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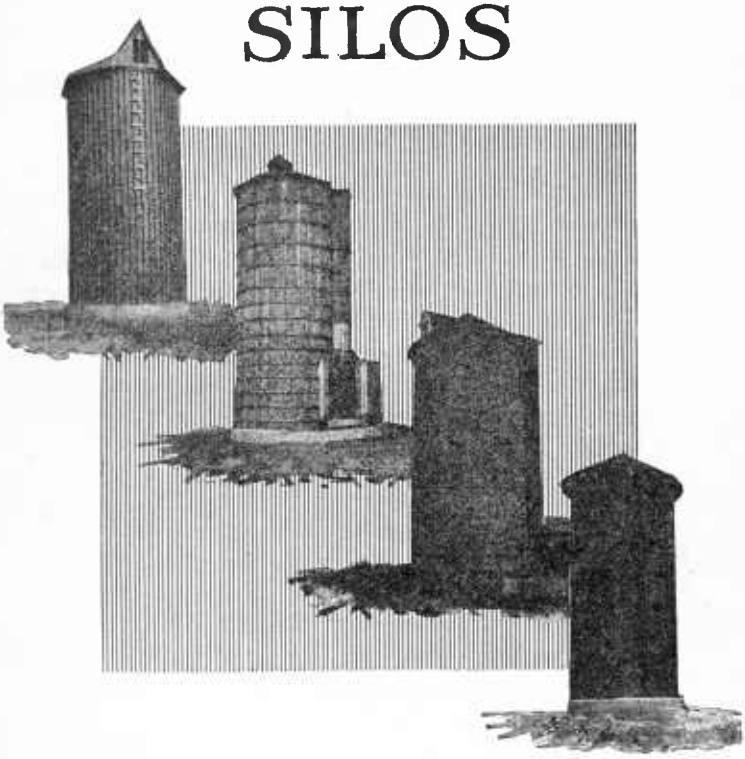
HOMEMADE SILOS



SILAGE is the best and cheapest form in which to store succulent feed. Many forage crops can be made into silage, but corn, where it can be grown successfully, makes the best silage.

Silage is well suited for feeding to all livestock. Dairy cows need it perhaps more than other classes of animals, because the succulence it supplies is favorable to large milk production. It is a cheap and economical feed for beef cattle, from breeding cow to fattening steer. Sheep like it and it is well suited to their needs. Even horses and mules may be fed limited quantities of good silage.

"Siloing" is an excellent way of preserving the mature corn crop or of saving one which for any reason must be harvested before maturity. About 40 per cent of the total food material in the corn plant is in the stalks and leaves. When the farmer harvests only the ears he loses nearly one-half of the crop; on the other hand, when the crop is put into the silo, the losses are very small. Satisfactory homemade silos of concrete or wood can be erected with little trouble.

Call on the extension department of your State agricultural college for any assistance that you may need in this respect. If the college is unable to help you, write to the U. S. Department of Agriculture for bills of materials, with full specifications for silos of different dimensions. They will cost you nothing.

Washington, D. C. Revised September, 1917, and August, 1922

HOMEMADE SILOS.

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CONTENTS.

USE AND ADAPTABILITY OF THE SILO.

THE SILO provides a means of storing and preserving succulent roughage for feeding farm animals, especially in winter when fresh green feed is not obtainable. It is adapted to all parts of the United States where corn or the sorghums can be successfully grown. Its use at present is confined principally to farms where cattle are kept, although silage is a good and cheap feed for both sheep and horses.[1] Dairy farmers especially have appreciated the value of silage as a milk producer. To make the silo a profitable investment, however, a man should have at least 10 cows or the equivalent in other stock. With a smaller number than this the relative cost of the silo and the silo-filling machinery becomes excessive; besides it is not usually feasible to build a silo small enough to accommodate fewer than 10 head.

KIND OF SILO TO BUILD.

After a person has decided to put up a silo, the next question is as to the best kind to build. Several factors will enter into this consideration, chief among which are cost and durability. On account of lack of space only four of the most common and approved types of silos will be discussed in detail here, namely, the concrete, the stave, the modified Wisconsin, and the wooden-hoop silos. The concrete silo, as the name implies, is built entirely of concrete; the stave silo is built of long 2 by 4 or 2 by 6 material, set vertically like the staves of a wooden tank; the modified Wisconsin silo is built of three-eighths or one-half inch boards nailed laterally on the inside of studding placed in the form of a circle. All these preserve silage equally well. The wooden-hoop silo is constructed of matched flooring and wooden hoops.

[1] See Farmers' Bulletin 578, "The Making and Feeding of Silage."

THE FOUR COMMON TYPES.

CONCRETE SILOS.

The concrete silo has the advantage of the other three in permanency and stability. The principal objection to the concrete silo is its first cost, which is generally greater than that of any one of the other kinds. A well-constructed concrete silo will last many years, as there is no danger of its blowing down, burning down, rotting out, or being attacked by vermin. For the man who wants a silo to last for a number of years and who can get the materials for concrete cheaply, this kind of silo is advisable because the expense of repairs is practically nothing and very little attention is required to keep it in good condition.

STAVE SILOS.

The stave silo has become very popular in late years because of the cheapness, ease, and quickness with which it is constructed. Generally speaking, the stave silo excels in these three particulars, although there may be sections of the country where sand and gravel may be obtained at a nominal cost and where the price of lumber is excessive. Under such conditions the concrete type may be the cheaper. Manufacturing firms have made a specialty of stave silos and have pushed their sale. As a consequence such silos are more numerous in the United States to-day than any other type.

Stave silos, however, are temporary structures, as they last only from 8 to 15 years, depending upon the kind and quality of lumber used, the care taken in their construction, and the climate. They are more liable to blow down or otherwise get out of repair than any of the other types.

THE MODIFIED WISCONSIN SILO.

It sometimes happens in certain sections that it is inconvenient to obtain hoops or lugs for a stave silo. Under such conditions the modified Wisconsin type or the wooden-hoop silo is to be recommended. The modified Wisconsin silo is more substantial than the stave silo; that is, it is not so liable to be blown down or to get out of repair by drying, and it does not need so much attention. In case some parts of the wall rot out they can be more easily repaired than those of a stave silo. Another advantage of this type over the stave silo is that carpenters as a rule more readily take hold of the work of construction. They seem to have a better idea as to just how to go about putting up this kind of structure.

There are two serious objections to the modified Wisconsin silo. One is that owing to the difficulty in bending the sheathing a silo less

than 14 feet in diameter is difficult to build, and the other is its unfinished appearance.

THE WOODEN-HOOP SILO.

The wooden-hoop silo requires somewhat less material than the other two types of wooden silos. The flooring used for the staves can usually be bought locally, and when a sawmill is available the hoops may be made from materials grown on the farm, such as oak, elm, ash, or chestnut. When home-grown material is lacking, beveled siding or three-eighths-inch yellow-pine ceiling may be used. The hoops are built up of several thicknesses of $\frac{1}{2}$ by 4 inch boards nailed together. The staves are nailed to each hoop with two nails, thus forming a rigid construction. It can be constructed with a smaller diameter than the modified Wisconsin silo. Carpenters, however, are generally unfamiliar with the style of construction.

COST OF CONSTRUCTION.

The cost of the above-mentioned silos depends so much upon their size and on the cost of material and labor that definite amounts which would be applicable to all conditions can not be fixed. Cost figures obtained for more than 300 silos show the comparative cost of constructing the different types of silos. While these figures, which are for silos built prior to 1915, are probably far too low for present-day costs and are therefore of little or no value as showing the actual cost now, they do serve to show how the different types of silos rank comparatively, as to cost.

The figures show that on a basis of cost per ton capacity the concrete silo was the most expensive, averaging $2.53 a ton, followed by the stave silo at $1.66 a ton, the modified Wisconsin silo at $1.61, and the wooden-hoop silo at $1.38. The size of silos also influenced the cost, the larger ones being constructed at a smaller cost a ton.

HOW TO OBTAIN PLANS.

Plans for these different types of silos, showing all details of construction, may be obtained without cost from the Bureau of Dairy Industry or from the Bureau of Public Roads and Rural Engineering. In requesting plans, state the size of silo desired; the kind of plan should be specified, as follows: Concrete silo, steel form for constructing concrete silo, stave silo, modified Wisconsin silo, wooden-hoop silo.

OTHER TYPES OF SILOS.

Other kinds of silos are the Gurler, hollow tile, brick, and stone.

The Gurler.—The construction of this silo is similar to that of the Wisconsin, the main difference being that the inner lining of wood in the Wisconsin type is replaced by a coating of lath and cement plaster. Its principal fault is that owing to lack of rigidity the concrete lining may crack and admit air.

The hollow tile.—This silo is constructed of hollow-tile blocks reinforced with steel, is apparently a durable and substantial structure, and the air space provides some protection against the freezing of the silage.

Brick silos and stone silos.—These silos have been used to some extent and with much satisfaction when properly constructed. When a good quality of brick is obtainable at reasonable price and labor is not costly this type may be built to advantage. Stone silos are expensive, however, and have nothing to recommend them as compared with concrete and other types of masonry silos.

ESSENTIAL FEATURES IN THE CONSTRUCTION OF SILOS.

There are some features which are essential to the construction of all silos and without which silage does not keep in perfect condition.

1. The walls should be air-tight. Since the keeping of silage depends upon the exclusion of air, it is imperative that the walls of the silo be built in such way as to exclude the air. The lumber should be well matched and contain no large knots. In concrete silos a wash on the inside with cement or with raw coal tar thinned with gasoline is effective in making the walls impervious to air. Care should be taken that the doors fit closely into their frames.

2. The walls should be smooth and plumb so that in settling the silage will not adhere to them and thus cause air spaces in its outer edge; furthermore, the walls should be capable of standing considerable lateral strain without cracking or bulging. This is one reason why rectangular silos are unsuccessful.

3. The silo must be so deep that the pressure from above will thoroughly pack the silage and force the air out. The greater the pressure the less air is left in the silo and the less will be the loss of food materials by fermentation.

4. The only form of silo to be recommended is the round one. Capacity considered, this form is the cheapest, and the walls are more rigid than those of the rectangular or octagonal form. This results in better preservation of the silage.

LOCATION.

The silo should be placed outside rather than inside the barn. As a silo ordinarily does not need the protection of a barn, it is not economical to use barn space for this purpose. An exception to this rule may be made in the case of the round barn. A silo in the middle of a round barn serves to support the superstructure as well as to place the silage in position for convenient feeding. A silo so placed, however, is liable to be very inconvenient to fill. The most popular location is not more than a few feet from the barn and opening into a separate feeding room; the door of the barn can then be closed and the silage odors kept out of the stable at milking time.

The silo should not be built in the ground so deeply as to make it necessary to lift the silage more than 5 feet in getting it out from the bottom. In other words, the bottom should not be more than 5 feet below the lowest door.

SIZE AND CAPACITY.

Diameter.—The diameter of the silo depends upon the quantity of silage to be fed daily. The silage should be removed from the top at the rate of 1½ to 3 inches a day, depending upon climatic conditions. The warmer the weather the more silage must be removed from the surface daily in order to prevent spoiling. For the winter-feeding season it is safer to figure upon removing 2 inches daily rather than a smaller amount. A common error in building is to make the diameter too large for the size of the herd. The weight of a cubic foot of silage varies according to the pressure to which it is subjected, but in a silo 30 feet high it averages about 40 pounds. So, by knowing the quantity of silage to be fed daily, it is possible to estimate what the diameter of the silo should be to permit the removal of a certain number of inches in depth each day. The table below shows the proper diameter of the silo for herds of different sizes to be fed different quantities for winter feeding, when 2 inches of silage are removed daily:

Relation of size of herd to diameter of silo for winter feeding (on basis of 40 pounds of silage per cubic foot).

Inside diameter of silo.	Quantity of silage in depth of 2 inches.	Number of animals that may be fed allowing—			
		40 pounds per head.	30 pounds per head.	20 pounds per head.	15 pounds per head.
Feet.	*Pounds.*				
10	524	13	17	26	35
11	634	16	21	31	42
12	754	19	25	37	50
13	885	22	29	44	59
14	1,026	25	34	51	68
15	1,178	29	39	59	78
16	1,340	33	44	67	89
17	1,513	38	50	75	101
18	1,696	42	56	85	113
20	2,094	52	70	104	139

A 900-pound cow ordinarily consumes 30 pounds of silage a day and a 1,200-pound one about 40 pounds. Yearlings eat about one-half as much as mature animals; fattening cattle, 25 to 35 pounds for each 1,000 pounds live weight. A sheep takes about one-eighth as much as a cow, and horses should be limited to 15 or 20 pounds daily.

The practice of using silage instead of soiling crops to supplement pastures during the summer droughts and in the early fall is becoming more general and should be encouraged. For such feeding the daily ration for each cow may be as low as 10 pounds, depending upon the amount and quality of pasture or other succulent feeds available. For the same herd the silo for summer feeding should be of smaller diameter than the one used for winter feeding, since 3 inches instead of 2 are to be removed daily. In order to provide for this summer feeding an additional silo of smaller diameter should be constructed.

The following table shows the relation between the size of the herd and the diameter of the silo when 3 inches of silage are removed daily:

Relation of size of herd to diameter of silo for summer feeding (on basis of 40 pounds of silage per cubic foot).

Inside diameter of silo.	Quantity of silage in depth of 3 inches.	Number of animals that may be fed allowing—			
		40 pounds per head.	30 pounds per head.	20 pounds per head.	15 pounds per head.
Feet.	*Pounds.*				
10	785	19	26	39	52
11	950	23	31	47	63
12	1,131	28	37	56	75
13	1,327	33	44	66	88
14	1,539	38	51	77	102
15	1,767	44	59	88	118
16	2,011	50	67	100	134

Height.—After the diameter of the silo has been decided upon, the next consideration is the number of tons of silage that will be required, and this is governed by the length of the silage-feeding season. The number of tons and the diameter having been fixed upon, reference to the table below will indicate what the depth of the silage should be. For example, if the diameter is 14 feet and the capacity 100 tons, the depth of silage after settling for two days should be 32 feet. An allowance of 4 to 6 feet must be made for settling in a silo 30 or more feet deep, so that the height of the silo in this instance from the floor to the plate should be 36 to 38 feet.

Depth of silage (after settling) for a given capacity of silo with a given diameter.[1]

Depth of silage (after settling 2 days).	Capacity of silo having an inside diameter of—									
	10 feet.	11 feet.	12 feet.	13 feet.	14 feet.	15 feet.	16 feet.	17 feet.	18 feet.	20 feet.
Feet.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
24	34	.....	.....	.....	.....	.....	.....	.....	.....	.....
26	38	46	55	.....	.....	.....	.....	.....	.....	.....
28	42	51	61	71	83	.....	.....	.....	.....	.....
30	47	56	67	79	91	105	.....	.....	.....	.....
32	.....	62	74	86	100	115	131	.....	.....	.....
34	.....	.....	80	94	109	126	143	161	.....	.....
36	.....	.....	87	102	119	136	155	175	196	.....
38	.....	.....	.....	110	128	147	167	189	212	261
40	.....	.....	.....	.....	138	158	180	203	228	281
42	.....	.....	.....	.....	.....	170	193	218	245	302
44	.....	.....	.....	.....	.....	.....	207	234	262	323
46	.....	.....	.....	.....	.....	.....	.....	250	280	345
48	.....	.....	.....	.....	.....	.....	.....	.....	.....	368

[1] These figures were taken in part from King's Physics of Agriculture, p. 424.

In general, the height of the silo should not be less than twice nor more than three times the diameter. On account of the pressure from above, the greater the depth the better the silage; if the silo is less than 24 feet in height the quality of silage will not be the best. Because of the excessive amount of power required to elevate the cut corn into the silo, a very great height is to be avoided.

FOUNDATION.

The foundation of the silo should receive special consideration, since a large part of the silage as well as the weight of the walls must be supported by the foundation. It has always been assumed that the foundation supports only the walls of the silo, but recent investigations have shown this idea to be erroneous. The foundation should have its base on firm soil, and it should extend below frost line. In the North it should be placed 4 feet or more below the surface of the ground, and 2 feet in the South. The dimensions of the foundation wall depend primarily upon the character of the soil and the size of the silo. The base of the foundation must be wider in loose soils than in clay soils, so as to prevent the walls from cracking and settling out of shape. The width of the base varies from 10 to 30 inches, depending upon the conditions mentioned.

FLOOR.

If the earth in the bottom of the silo is firm and comparatively dry, no provision need be made for drainage, and a floor is unnecessary; still a concrete floor will make the silo easier to clean and make it impossible for rats to burrow underneath the foundation wall and gain access to the silage. If, however, the earth in the bottom of the silo is inclined to be seepy, a tile drain should be laid in it and

a concrete floor laid above the tile. The tiling should open into the floor in the center, and the floor should be made to drain to it. The tiling should extend beyond the silo wall and have its outlet lower than the floor. The entrance of the tile drain should be stopped with a loose wooden plug when the silo is about to be filled and should be kept open when the silo is empty. The drain will carry off the water which tends to seep in, as well as any rain water that may collect on the floor in case the silo has no roof.

DOORS.

The doorways have always been a source of weakness in silo construction. When poorly made they have sometimes caused the silo to crack open and spread. Ample provision should therefore be made for reinforcing that part of the structure near the doors. The door should form an air-tight joint with its frame; tar paper is oftentimes useful for that purpose. The door should be flush with the inner wall of the silo so that air pockets will not form as the silage settles.

Doors should be of such size as to permit the ready entrance of a man, and they should be so close together that the silage will not have to be lifted any considerable height to remove it. The usual size is about 20 inches wide and 30 inches high, and the space between the doors 2½ to 3 feet. The lowest door should not be more than 5 feet above the bottom of the silo, and less than this is desirable. The table below will assist the builder in determining the number and spacing of the doors:

Number and spacing of doors in silos of different heights.

Height of silo above foundation.	Number of doors.	Height of door.	Space between doors.	Space below first door, to foundation or surface of ground.	Space above last door.
Feet.		*Feet.*	*Feet.*	*Feet.*	*Feet.*
24	4	2½	3½	1	3½
26	5	2½	2½	1	2½
28	5	2½	3	1	2½
30	6	2½	2½	1	1½
32	6	2½	2¾	1	2¼
34	6	2½	3	1	3
36	7	2½	2½	1	2½
38	7	2½	2¾	1	3
40	8	2½	2⅝	1	1½
42	8	2½	2½	1	3½
44	8	2½	3	1	2
46	9	2½	2½	1	2½
48	9	2½	2¾	1	2½

THE CONTINUOUS DOOR.

Many silos are now built with continuous doors, obstructed only by the hoops or bars extending from side to side, which are necessary to prevent the doorframes from spreading. This kind of door is more convenient for the removal of silage.

ROOF.

While a roof is not essential to the keeping of silage, it is for several reasons advisable to equip the silo with one. A roof adds to the appearance, life, and stability of the silo; it retards freezing; it keeps rain and snow out, making the work of removing the silage more agreeable; it will also prevent the silo from becoming a feeding ground for pigeons. There should be a door in the roof large enough to admit the carrier or blower from the cutter. A simple trapdoor answers the purpose, but a dormer window with glass is preferable, as it admits light and so makes the use of a lantern unnecessary when the silage is being removed.

CHUTE AND LADDER.

A chute should be built over the doors to prevent scattering of the silage when thrown down. This makes it possible to catch all the silage in a truck.

A ladder should be attached to the silo at one side of the doors or in the chute. Sometimes the reinforcing rods of the continuous door or the hoops may be used as a ladder.

THE CONCRETE SILO.

Concrete silos are of three kinds—those built of concrete blocks, those made with concrete staves, and those with a solid wall, or the monolithic type. The only advantage of the concrete block silo over the monolithic is that the walls can be more easily built with an air space, which tends to prevent freezing. It is probable, however, that the difference between the two walls in this respect is of no considerable importance. It has the disadvantage of being more difficult to construct and requiring more expert labor, and as a consequence it generally costs more to build. On account of the limited space which can be devoted to a discussion of silo construction, the solid-wall or monolithic type is the only one which will be described in detail in this bulletin.

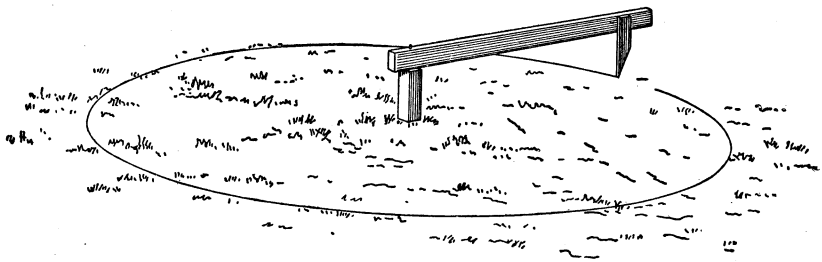

FIG. 1.—Laying off the foundation for a concrete silo.

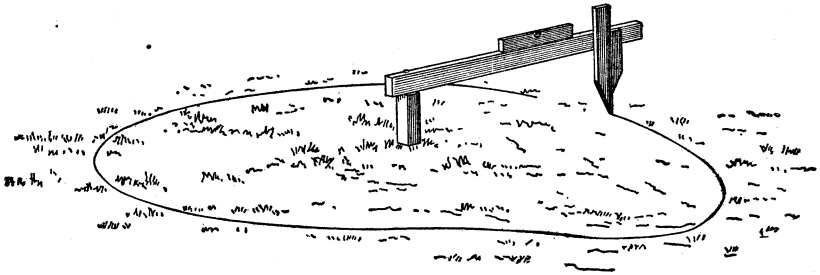

FIG. 2.—Laying off the foundation on sloping ground.

FOUNDATION.

To lay off the foundation, drive a stake in the ground at the center of the proposed silo. One end of a straight 2 by 4 inch scantling, a little longer than is necessary to reach from the center of the silo to the outside of the foundation wall, should be nailed on top of the stake with a 40-penny spike; this spike then marks the exact center of the silo. From it measure off on the scantling the distance to the outside of the foundation wall, and having nailed a marker on, as shown in figure 1, lay off the foundation.

Where the ground on which the silo is to be built is not level, the marker should be lengthened by holding a longer board against it (see fig. 2), and moving it up or down to keep it touching the ground while the scantling is held level. If the ground is very uneven it may be difficult to make the line continuous, in which case points should be marked every few inches and joined afterward.

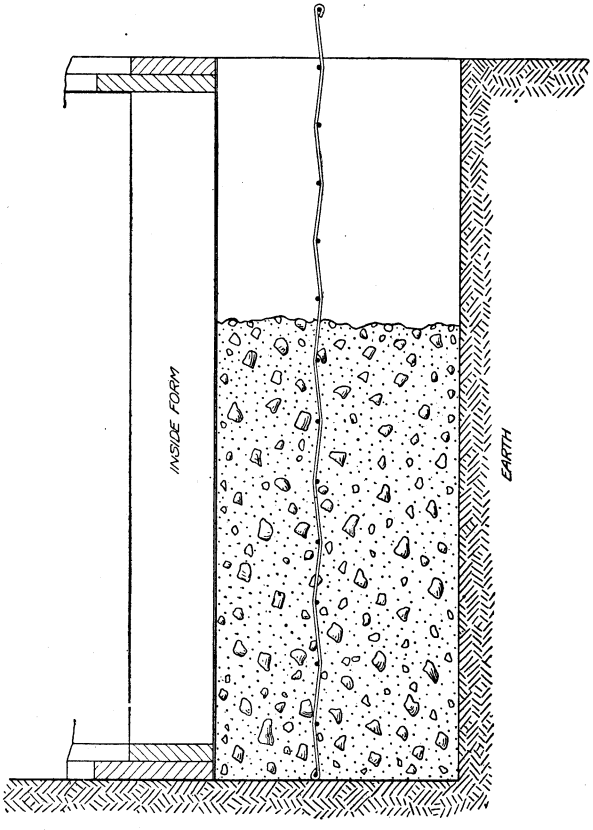

FIG. 3.—Method of constructing foundation in firm soil.

The earth inside the circle must be excavated to firm ground below the frost line. A plumb line should be used in digging the pit so that the walls can be dug true to the mark. Generally the earth is firm enough to stand without danger of caving, and may serve as an outside form in building the foundation. (See fig. 3.)

If, however, the dirt caves in, the foundation should be built as shown in figure 4, in which case the pit must be dug large to give ample room for placing and removing the outside form. Aside from the matter of reinforcing, most of the failures of concrete structures have been caused by poor and insufficient foundations, and special care should be taken to make this part of the silo secure. If the location is unfavorable for a good foundation and the silo is of very large capacity, it is well to put in a special footing to distribute the weight over a larger area of ground. (See fig. 4.)

MAIN WALL OF SILO.

The main wall of the silo is built 6 inches thick throughout, although for diameters of 12 feet and under a wall 5 inches thick has been found sufficient. No modification is made in the thickness of

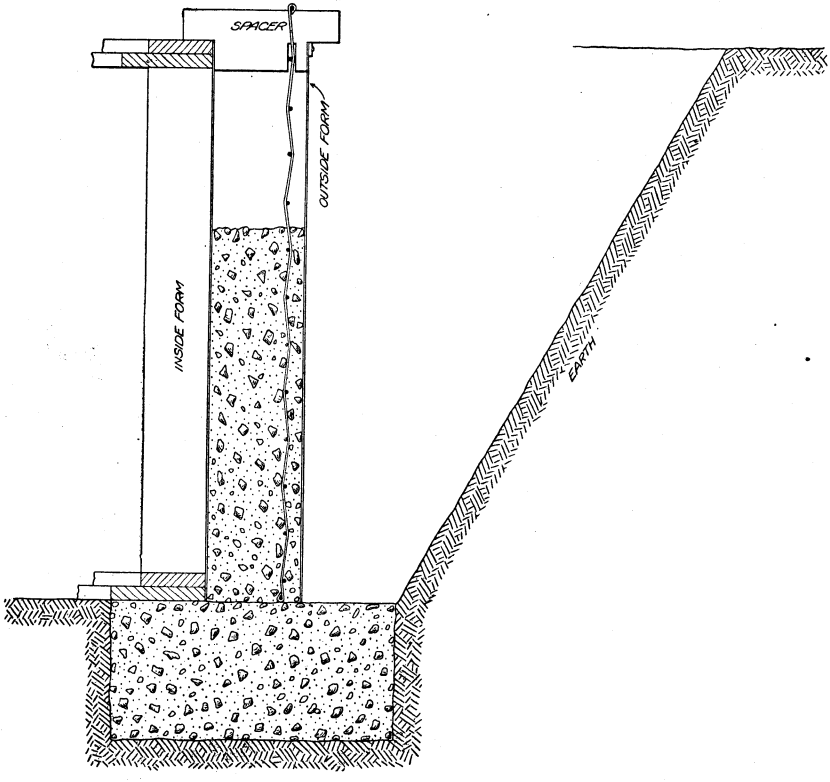

FIG. 4.—Method of constructing foundation in loose soil.

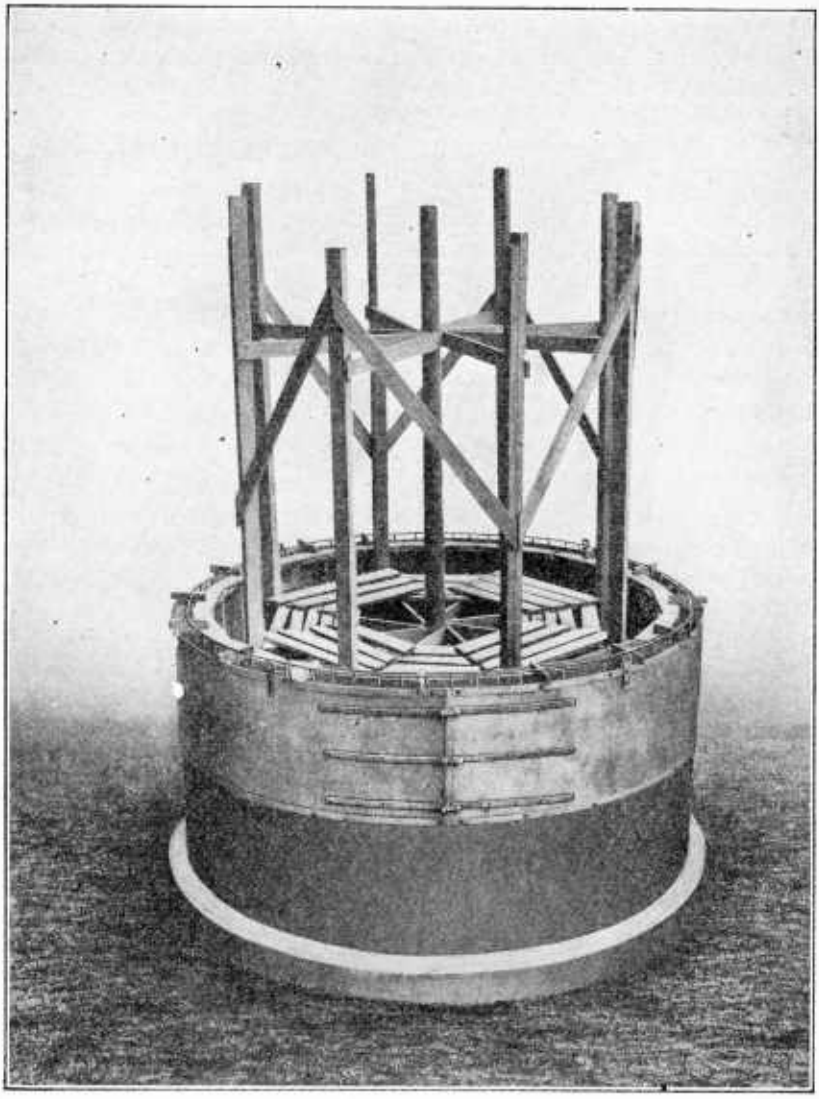

FIG. 5.—Silo form in position.

the wall for top and bottom, because the expense of adjusting the forms for such a variation more than equals the saving in cost of materials.

For building the wall two circular forms are needed, one inside the other, with a 6-inch space between them, into which the concrete is poured. The forms are built 3 feet high, and approximately 33 inches of wall can be built with each setting of the forms. The forms are so constructed that after each course of 33 inches of the wall has been placed the forms can be loosened, raised, and placed in posi-

tion for another 33 inches of wall. (See fig. 5.) In resetting, the forms are allowed to lap over the old wall about 3 inches, which greatly assists in getting them into proper position.

FORMS.

Sheet metal or wood may be used for forms, but the metal is much to be preferred. It does not make so heavy a form as the wood, and the finished wall is smoother. Twenty-two gauge black or galvanized sheet iron 36 inches wide may be used. If, however, the diameter of the silo is to be 16 feet or more, it has been found more practicable to have the sheets 30 inches wide, because in such cases one course around the silo at the reduced height of wall would be sufficient for an average day's work. The advantage of galvanized over black iron is that the form will last for a considerable time, and if properly cared for can be used several seasons for a number of silos of the same diameter.

For the inside form it is necessary to build two supporting circles (see figs. 5, 6, and 7). to which the sheet iron or wood, as the case may be, is nailed. These circles are built of 1 by 6 inch material, rough or dressed, of a length depending upon the diameter of the silo, so that 16 pieces will exactly make the circumference. It is not an easy matter to compute these lengths of chords for the various diameters, so they are given below. In figure 6 the chord is the distance from A to B.

Table of chords.

Diameter of silo.	Chord measurement.
	Ft. *In.*
10 feet....	1 $11\frac{3}{8}$
11 feet....	2 $1\frac{3}{4}$
12 feet....	2 4
13 feet....	2 $6\frac{3}{8}$
14 feet....	2 $8\frac{1}{4}$
15 feet....	2 11
16 feet....	3 $1\frac{1}{2}$
17 feet....	3 $3\frac{3}{4}$
18 feet....	3 $6\frac{1}{8}$
20 feet....	3 $10\frac{3}{4}$

LAYING OUT THE TEMPLETS FOR SHEET-IRON FORMS.

Figure 6 shows how to lay out the pieces to be used as templets, or patterns, by which to cut the pieces which

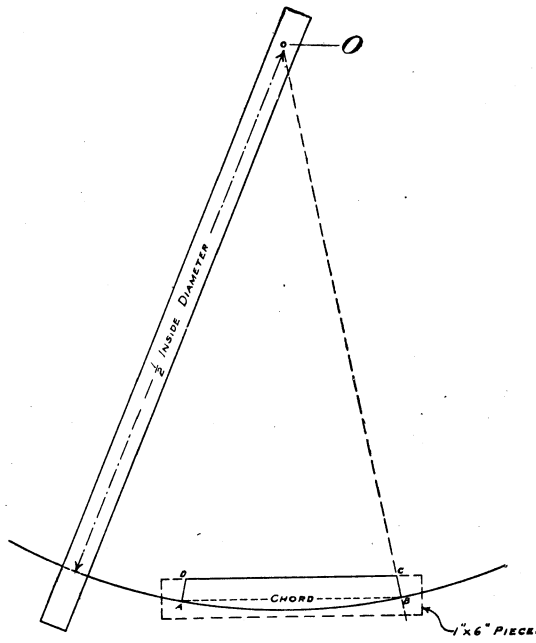

FIG. 6.—Method of laying out templets.

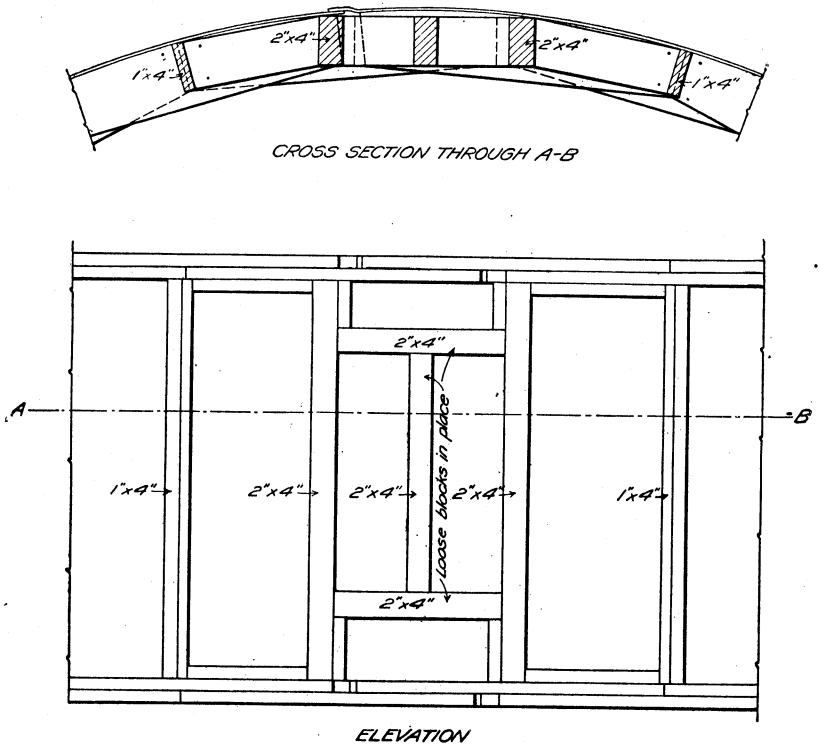

FIG. 7.—Portion of inside form, showing method of fitting and releasing the form from the wall.

when laid end to end are to form the supporting circles for the inside form when sheet iron is used. For this part of the work use the barn floor or any other clear space available. If there is no convenient place available, it will be advisable to use a concrete mixing board, described elsewhere in this bulletin.

Select a straight piece of 1 by 3 inch board about a foot longer than half the diameter of the proposed silo, and with a 10-penny nail tack one end to the floor so that the slat will be free to swing about. From this nail as the center of the silo, measure on the slat one-half the length of the inside diameter. Here drive a nail until the point extends through far enough to scratch a clear mark on the floor as the slat is swung around on the center O, as shown in figure 6. This circle represents the inside face of the wall. An arc equal to one-quarter of the circumference is sufficient. From any point which has been determined to be A on the arc, measure the length of the chord in figure 6 as given in the table of chords for the diameter of the proposed silo, and find point B. With a straightedge laid through the points A and O, and also through B and O, draw short lines on the floor from D to A and from C to B, respectively. On these lines

measure inward 4 inches from points A and B, and locate points C and D.

Next take a piece of the 1 by 6 inch board and lay it on the arc with the inside edge flush with points C and D, as shown in figure 6. With several small nails tack it to the floor; then lay off the arc again on this piece, and with the straightedge re-mark lines AD and BC. The piece is now ready to be taken up and sawed. The resulting pattern, or templet, will serve to mark out the 64 pieces necessary to build the two inside circles.

The curved pieces can be sawed by hand, but it is better and cheaper to have the work done in a mill or shop equipped with a band saw.

BUILDING THE CIRCLES.

Each of the supporting circles is built two-ply; that is, the pieces are lapped so as to break joints. After cutting four or five pieces, lay them out on the circle so that they will fit the curve. Before starting to nail the pieces together, mark out the whole circumference on the floor or on level ground with the slat, as shown in figure 6, and build the circles accurately by laying the pieces flush with the mark. It is important that the circles be well nailed with 8-penny nails driven through and clinched. While the circles are being built approximate points of division into quarter circles can be marked, and those pieces nailed sparingly until after the circle is completed. It is generally safer to build the circles complete and then divide into quarter sections rather than to build each quarter

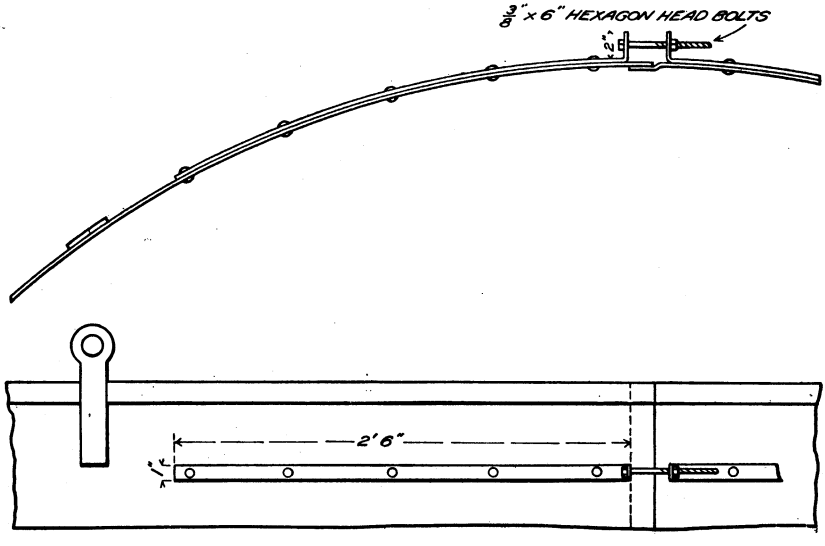

FIG. 8.—Method of joining sections of outside form.

separately; this division into parts is for the purpose of loosening and resetting the forms.

Remove the nails in one-half of every fourth piece in the top layer of each circle. This divides each circle into four equal parts, with lapped joints.

BUILDING THE INSIDE FORM.

Three inches should be cut from each end of each quarter section of the circle to allow the sections to slide together when they are to be removed from the wall. Next, temporarily nail the quarter sections together at points of division and brace the top circle directly over and 32 inches above the lower one. See that both circles are perfectly level and that the joints in the upper circle are directly above the joints in the lower circle, and then proceed to nail in securely, between the top and bottom circles, 1 by 4 inch studding, 32 inches long, placing the studs carefully plumbed from 12 to 18 inches apart, as shown in figure 7, to keep the iron from bulging. The end studs in each quarter section should be of 2 by 4 inch material, supported on 1 by 4 inch blocks cut in between the 2 by 4 inch stud and the next 1 by 4 inch stud, and nailed to the circles. Blocks 1 by 4 inches should then be nailed on the opposite side of the 2 by 4 inch studs to hold in place the loose blocks which are used in fitting or releasing the forms from the wall. (See fig. 7.)

Nail the sheet iron on with 6-penny nails, and nail securely, but before beginning to nail the iron on see that it is cut to the proper length. The sheet for each quarter section should be just 3 inches longer than one-quarter of the circumference. If several sheets are required to make a single quarter section, they should be carefully riveted together with a double row of flat-headed rivets. Since the quarter sections lap 3 inches, and in removing need to slide together several inches farther, it is necessary to leave one end of the sheets loose 8 to 10 inches from the end, while at the other end it should be nailed all the way.

BUILDING THE OUTSIDE FORM.

The outside form is made up of four sections of 22-gauge black or galvanized iron, each section being 3 inches longer than one-quarter of the outside circumference of the wall, to provide for the lap. The upper edge of each section is reinforced on the outside with a $\frac{3}{16}$ by $1\frac{1}{4}$ inch strap iron securely riveted to the iron and cut back about 3 inches from each end of the sheet to allow for lapping.

Lugs and bolts for outside form.—The quarter sections are joined and drawn together by means of bolts and lugs, the latter made from $\frac{3}{8}$-inch tire steel and riveted on the forms, as shown in figure 8; 3 pairs

of lugs bent to the outside circumference of the wall are used at each joint, the lowest pair being placed 2 inches from the lower edge of the form, the upper pair 4 inches from the upper edge of the form, and the third pair halfway between. Note that in one end of the section the lugs are riveted in flush with the edge of the iron, while at the other end they are set in .4 or 5 inches from the edge, to permit a lap. The lugs should be made about 32 inches long, bent up 2 inches at one end, in which a ½-inch hole is drilled. The lugs are securely riveted to the sheets with five flat-headed rivets in each strap. For drawing the sections together use ⅝-inch bolts 6 inches long with hexagonal or square heads and nuts and extra long thread. (See fig. 8.) The forms are then ready for use.

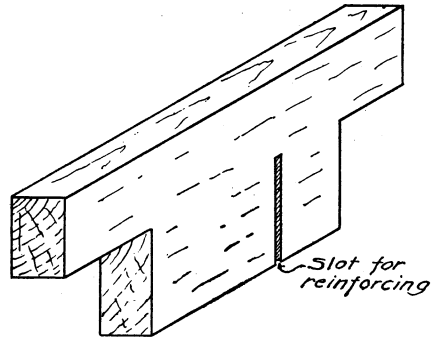

FIG. 9.—Spacing block.

Two wrought-steel eyes should be riveted to the upper edge of each section to facilitate raising the form.

SETTING THE FORMS.

In building the wall the inside form is used from the footing up. Generally for the first 3 feet of wall the outside form is not needed, the earth wall of the pit serving in place of the outside form. As soon as the wall reaches the top of the ground the outside form must be placed in position. The outside form should be so placed that one of its joints will come on the center line of the door openings. In order to space the outside form exactly 6 inches from the inner it may be necessary to saw a number of blocks 6 inches long and place them at intervals along the bottom to hold the form temporarily in place. As the concrete is filled in, the blocks must be removed, as to leave them in the wall might permit air to enter the silo at those points. For spacing the forms at the top a number of pieces of the shape shown in figure 9 will be found useful.

The greatest care must be taken to have both forms level across the top and the sides plumb. If on one side of the silo the forms are higher than on the other they are out of round, and consequently the wall at some places will be thicker than at others, thus making it impossible to build the wall plumb. The diligent use of a plumb bob and a good level, to see that the forms are plumb and level at each raising, will save much annoyance later.

SCAFFOLDING.

As soon as the forms are in place for the first time, it is well to start the scaffolding shown in figure 10, which supports the forms and from which the work is done. It is less expensive and also more convenient to have the working platform on the inside of the silo rather than on the outside. For this scaffold 2 by 4 inch scantling doubled is the most convenient material, but long straight poles can be used equally well, and frequently at much less expense. It is well to set the poles or scantlings in the ground 4 to 6 inches in order to make them more secure, and they should also be securely braced. Figure 10 shows how they are arranged. The number of uprights needed will vary with the diameter; silos of small diameter may require only 9, while for large silos 17 or more may be found necessary. The number needed for the outside scaffold will vary in proportion. The uprights on the inside are set in from the wall 12 inches to permit the removal of the form. If the uprights are too close to the wall it will cause trouble, as in raising it becomes necessary for one form to pass by the other; the uprights should be set plumb with a straight side toward the wall.

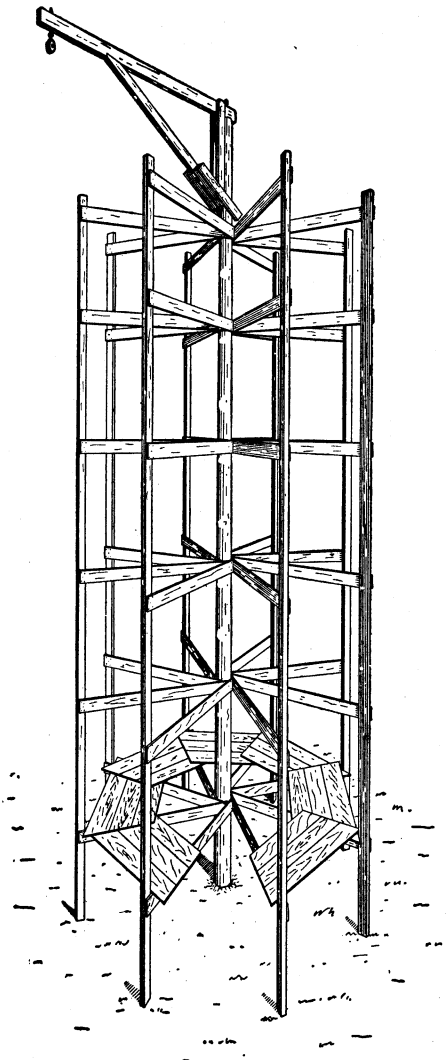

FIG. 10.—Scaffold used in constructing concrete silo.

REINFORCING.

Concrete, like all other masonry work, must be reinforced when subjected to a pulling or bending stress; of itself it has a low tensile strength. Silage is a heavy material and exerts considerable pressure upon the walls; in addition to this pressure there is also wind pressure, which on occasion is considerable, but the circular walls, together with the numerous strands of wire in the kind

of reinforcement recommended are more than sufficient to prevent failure.

The material used for reinforcement may be steel rods, bars, or ordinary wire, provided the amount used is sufficient to withstand the pressure. The most convenient material to use and one that is readily obtained anywhere at a reasonable cost is the common woven or welded steel hog fencing, 32 or 34 inches wide, with horizontal strands of No. 9 wire. This wire is easily placed in position, and is not easily displaced while filling the form.

Reinforcing, to be most effective, must be placed near the surface, where the pull comes. In a silo wall this is on the outside, so that the reinforcing should be placed from 1 to 2 inches inside the outer surface. Since the strength of the wall depends largely upon the reinforcing used, it is never advisable to use old or damaged wire, and the wire should be free from kinks or sharp bends. If the silo wall is more than 30 feet in height, the first three or four courses should have the reinforcing doubled to meet the increased pressure on the lower portion of the wall.

In the table below is given the length the fencing is to be cut; the lengths given allow 6 inches for use in fastening ends together securely so that there is no chance of slipping.

Each course of reinforcement should be securely laced to the preceding course, No. 16 soft wire being used for the purpose.

Length to which to cut fencing for reinforcing concrete wall.

Diameter of silo.	Length of fencing required to make circumference.[1]	Diameter of silo.	Length of fencing required to make circumference.[1]
Feet.	*Ft. In.*	*Feet.*	*Ft. In.*
10	34 3	15	50 0
11	37 5	16	53 1
12	40 7	17	56 3
13	43 8	18	59 5
14	46 10		

[1] Includes 6 inches for fastening.

Special care must be taken to have the reinforcing around the doors as strong as in any other part of the wall. Figure 11 shows how a ⅝-inch rod, or its equivalent, should be placed on each side of the opening about 2 inches from the door form. The horizontal strands of the fencing are cut to admit the door form, and the ends are securely wound around the iron rods; the rods should extend 6 or 8 inches above and below the door openings and should be tied with several strands of No. 8 or 9 wire.

PREPARATION OF THE CONCRETE.

CEMENT.

Only the best Portland cement on the market is suitable for building thin reinforced walls such as are used in silo building. Portland cement comes packed in either barrels or sacks, four sacks equaling a barrel. In buying cement care should be taken to see that the stock is fresh; when stored where it can absorb moisture it becomes lumpy, hard, and unfit for use. Hardness, however, is not always an indication that the cement is unfit for use, as it may become hard if stored under considerable pressure, and if the pressure is not combined with a moist condition the cement may again be pulverized and used. Unless there is a good, dry place in which to store the cement it should not be purchased until it is needed. If circumstances require storing temporarily, select a dry place protected from the weather and pile the cement on a board floor.

SAND.

Sand for building a silo should be coarse, and above all it should be clean—that is, free from clay or vegetable matter. Fine sand is objectionable because it does not make so strong a wall as coarse sand and also because it requires more cement. A mixture of coarse and fine sand, however, makes good, strong concrete. A common method of testing sand for vegetable loam is to place a small quantity of the sand in a bottle partly filled with water, shake it thoroughly, and allow it to settle. The impurities will settle on top of the sand and can thus be readily measured. If the layer of impurities is more than one-tenth of the thickness of the solids, the sand should be rejected or washed before it is used.

CRUSHED STONE OR GRAVEL.

The bulk of concrete consists of gravel or crushed stone that is added to the sand and cement. Other materials, such as pieces of hard brick, oyster shells, and cinders, can be used instead of the crushed rock. Crushed stone is the best because it is more sure of being clean and of the right size. Gravel taken from a creek is often coated with clay loam, which prevents the cement from making a good union, and very often it contains particles that are too large or of a crumbly character; such gravel should be run over a screen and washed before using.

Soft granite, shale slate rock, or dusty cinders are not desirable. Whatever material is used should be free from dust and dirt; it should not easily crush and disintegrate, and should be suitable to give a good, strong union with the cement.

In some localities there are natural deposits of gravel containing varying proportions of sand. If clean and not too coarse, such

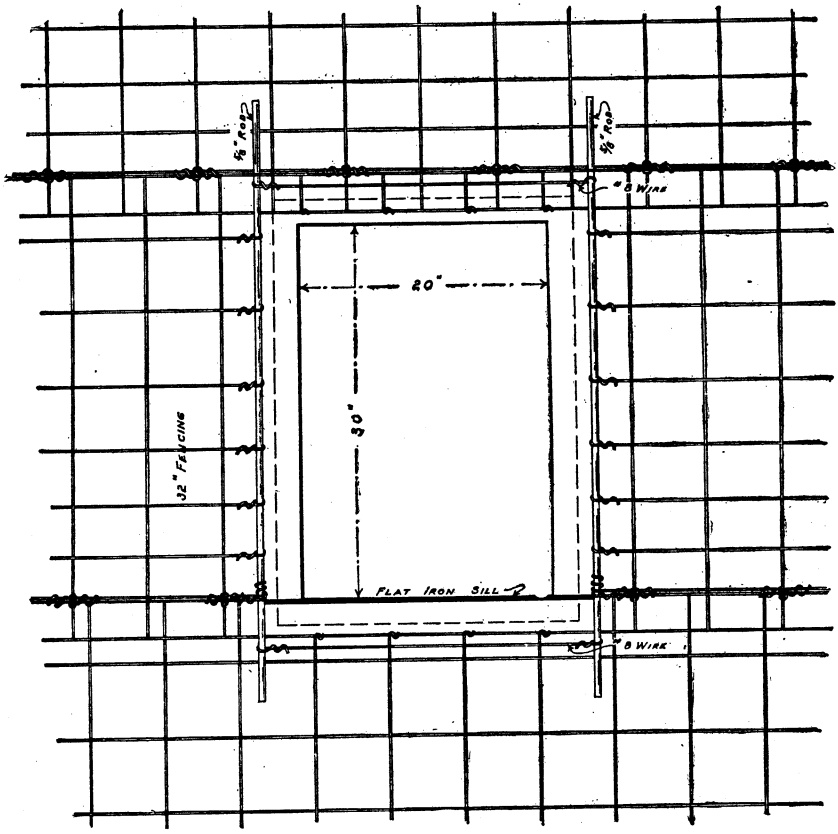

FIG. 11.—Position of reinforcing rods around door opening.

gravel is well suited for silo building, but in using this material it is never safe to assume that the proportion of sand to gravel is correct until a quantity has been run over a screen (¼-inch mesh) and the exact proportions determined. Usually the gravel contains too much sand.

For the foundation the stone may be as large as will pass through a 2½-inch ring, while for the main wall of 6-inch thickness the size should not exceed 1½ inches. A mixture of particles of various sizes from ½ to 1½ inches makes the strongest wall.

WATER.

The water used for mixing concrete should be clean and free from alkalies and acids. The drainage water from the barnyard or water from a muddy stream is unfit for use.

PROPORTIONS.

For the foundation use a 1:3:6 mixture; that is, a mixture of 1 part cement, 3 parts sand, and 6 parts crushed rock. For the main

wall use a 1:3:5 mixture, or 1 part cement to 3 parts sand and 5 parts rock. These proportions apply when all the material is first class. If the sand is fine, the proportion of cement must be increased 10 or 15 per cent to insure a strong mixture.

The mixed concrete should be placed promptly after mixing, before it begins to set; therefore in silo building it is not advisable to mix up very large batches at a time. After the silo wall is above a man's reach as large a batch as ought to be attempted is what is known as a two-bag batch, or the quantity of concrete that requires two bags of cement.

MEASURING.

The measuring of the different ingredients for concrete is an important part of the work and requires care and attention. The best way to measure sand and gravel for such a batch is to use a frame or measuring box, as shown in figure 12, *a*. For a 1:3:5 mixture this frame should measure, inside, 4 feet 7 inches long, 2 feet wide, and 12 inches deep. On the inside of the frame, 33½ inches from one end, a partition is placed crosswise of the box. When measuring the rock this whole frame is filled level full, and for measuring the sand use only the largest division of the frame level full.

MIXING BOARD.

The first requirement for mixing is a level, water-tight platform. The smallest size found convenient in silo building is 9 by 10 feet. With a board of this size one batch can be put into the forms while another is being prepared; the process of filling is made continuous, and all the working force is constantly employed. The platform or mixing board should be built of dressed 1-inch lumber nailed to a sufficient number of 2 by 4 inch cleats to prevent sagging. If 2 by 4 inch pieces are nailed around the edge of the board, they will help prevent loss of material in the process of mixing.

The platform should be placed with one end not more than 2 feet from the silo wall, so that the mixture can be shoveled from the board into the buckets used in hoisting, thus avoiding all carrying. The position of the mixing board should be determined before any of the sand and gravel are delivered, so that these materials can be piled in the most convenient place.

The following-named implements are needed for mixing the concrete: A water-tight barrel, placed at one side of the mixing platform and filled with water for each batch; a 2-gallon water pail; two or three square-pointed, short-handled shovels, an ordinary garden rake, and two hoes, for mixing and handling the concrete, and two wheelbarrows for bringing the sand and gravel to the concrete board. With this preparation the work of mixing should proceed without interruption.

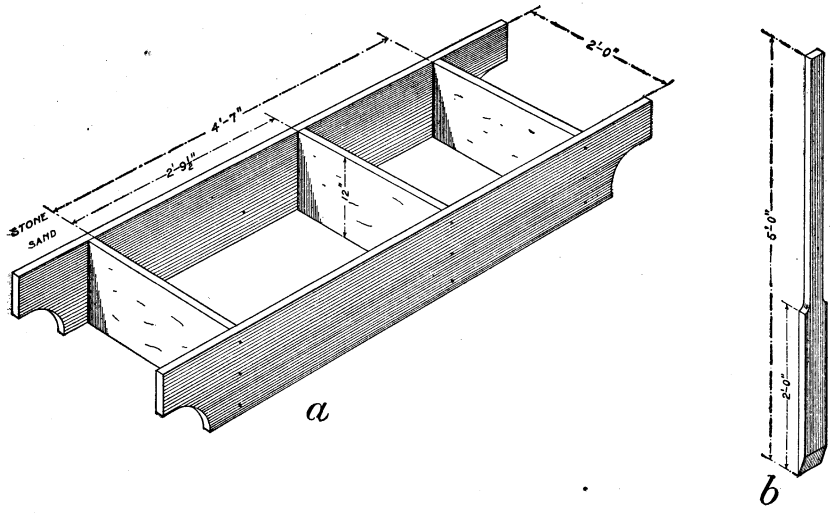

FIG. 12.—Measuring box for concrete materials.

MIXING.

Place the measuring box at the end of the board farthest from the silo, and with the wheelbarrows bring up the sand and fill the largest division of the frame level full. (See fig. 12, *a*.) Then lift the frame off and set it to one side, leaving the required quantity of sand on the board. Spread the sand out evenly to the depth of not more than 4 inches and over it distribute the two bags of cement. Two men with the square-pointed shovels then turn the mixture over until it is of a uniform color, showing that the mixing is done well. In turning the mixture over the men should shovel from the same side of the pile. As each shovelful is turned the shovel should be so held that the material is scattered instead of dropped in a body. If a third man is available, he can assist in the mixing by raking the pile over as it is being turned. Turning the pile over three times in this way should be sufficient to mix the sand and cement thoroughly, but if it is streaky and of uneven color it must be turned again.

At the last turning the mass should be rounded up into a low, craterlike pit, and the water added by pouring it into the crater. With the field hoes the sides and bottom of the crater are pulled in gradually, water being added until the whole mass is uniformly wet and of about the consistency of thin mortar. Spread the pile out so that it is not more than 3 or 4 inches deep, set the measuring frame over it, and fill the latter level full with the crushed rock or its equivalent. Each barrowful of rock should be thoroughly wet to wash the dust off before dumping it into the measuring frame. When filled, lift the measuring frame off and shovel on top of the pile the mortar that is not covered. Turn this mass over at least three times and in such way that the last turning will place it next to the silo con-

venient to the hoisting buckets. During this mixing, water may be added if required to bring the mass to the proper consistency.

The most convenient device for carrying and pouring the concrete into the forms is an ordinary coal scuttle, and if care is taken not to overload them, three will last for the whole job. For elevating the buckets set up a rope and single pulley, such as is used over open wells.

FILLING THE FORMS.

In filling the forms, only a few inches in depth should be filled in at one place at a time. Depositing a great quantity of concrete at one place puts a heavy strain on the forms and has a tendency to force them out of plumb. As the concrete is put into the form it should be spaded with a piece of 1 by 3 inch board, sharpened to a bevel edge as shown in figure 12, *b*. The purpose of the spading is to remove all air bubbles and avoid the formation of cavities. On the other hand, in a wet mixture as used in silo building the spading must not be overdone, or the heavier rock will sink to the bottom and the cement and water will rise to the top.

The exterior surface can be kept smooth by greasing the outside form with soap or some cheap oil or grease. To be effective this grease coat must be renewed at each raising of the forms. No grease should be used on the inside form, as this surface is to receive a brush coat of pure cement wash. Small particles of cement will adhere to this form each time it is raised, and before it is used again they should be removed with a broom or a wooden trowel. If they are not removed, an undue quantity of concrete adheres, which makes the wall unnecessarily rough.

As the forms are raised the fresh wall is constantly exposed to the drying air and sun, and there is danger of the surface drying and curing too rapidly for the interior of the walls, thus causing cracks. To prevent this the wall should be soaked with water several times a day for a few days, and when possible it should be protected with canvas or burlap, thoroughly wet.

When the forms have been filled for the day do not smooth the top with a trowel, but leave it as rough as possible. A good plan is to roughen the top surface just as the concrete begins to set. The next day, before putting fresh concrete on the wall, the top surface should be soaked with water and then sprinkled with raw cement, which will help in making a good union between courses.

At the end of each day's work the mixing board and all tools should be washed free from cement; otherwise the next day's work will be tiresome.

INSIDE SURFACE FINISH.

A brush coat of cement wash, prepared by mixing cement and water to the consistency of thick lime whitewash, should be applied

in the usual way as soon as the form is raised and before the wall has had time to dry. The cement helps to make the wall less porous and therefore more nearly air-tight and water-tight. If the wall has dried, it should first be drenched with water.

After the coat of cement wash has been applied the whole interior should be painted with coal tar thinned with gasoline. The coal tar makes the wall impervious and also protects it from the possible action of acids which develop in the silage. It should be renewed from year to year as may be required. The application of coal tar may be left until the wall is complete, but should be done before removing the interior scaffold.

RAISING THE FORMS.

Before loosening the forms for raising, a straightedge should be laid across their tops and leveled, and marks made on the uprights of the scaffold to show the position of the next set of supporting brackets for the inner form, which will be just 3 inches below the top of the forms. If this is done carefully little trouble will be experienced in resetting the forms.

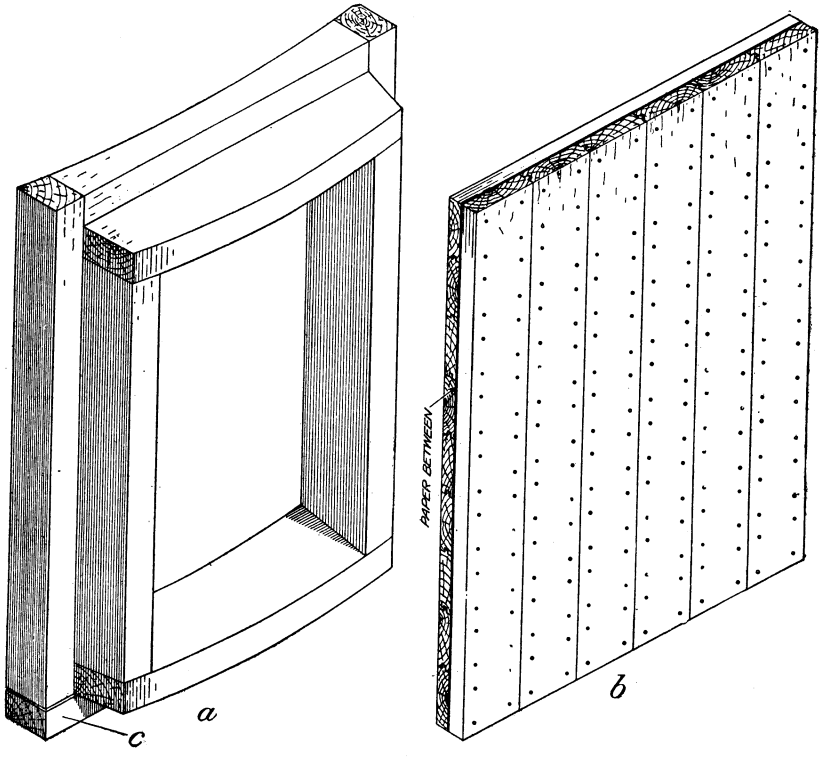

FIG. 13.—Door and form for door opening.

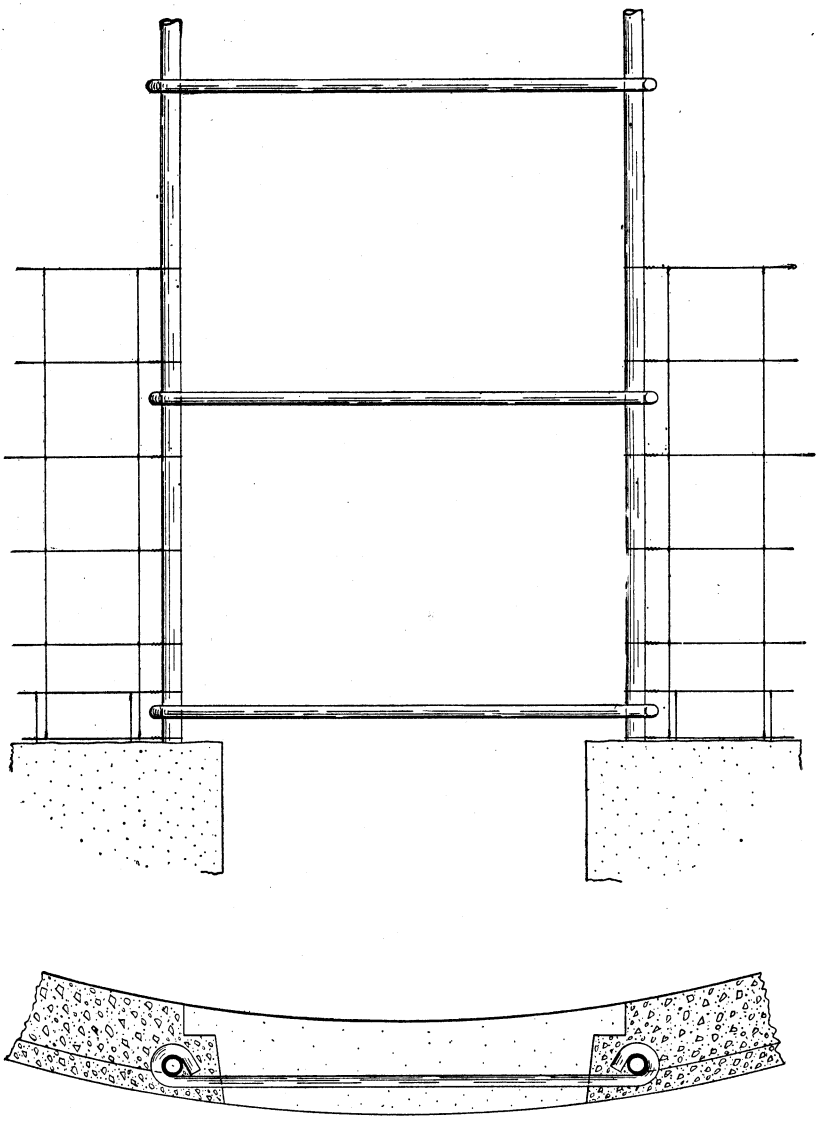

FIG. 14.—Detail of reinforcement for continuous door opening.

Small hoisting ropes are attached to the hoisting eyes in the top of the outside form; the bolts in the lugs at the joint of the form which is on the center of the door openings are now loosened sufficiently to permit the release of the form from the wall. By means of the hoisting ropes the form is raised to its new position and clamped temporarily to the wall by means of the lower lugs, or held suspended by the hoisting ropes attached to brackets from the scaffold. The reinforcement is set for the next course and laced to the reinforcement of the preceding course. Next, the loose blocks of the inside form are

removed and the form is lifted by sections and placed temporarily on top of the wall. The supporting brackets are nailed in place and the working platform relaid. This done, the sections of the inside form are set in place on the brackets and the form clamped against the wall by replacing the loose blocks; the blocks should be so identified that they will not be interchanged.

Both forms should now be plumbed and leveled, the outside form clamped in place, and spacing blocks inserted between the forms in sufficient numbers to hold the outside form to a true circle.

In raising the forms and in the process of building, care should be taken to avoid jarring the wall by heavy pounding, which is likely to injure the concrete in the process of setting.

The forms should not be removed until the concrete has set sufficiently. A good working plan is to raise and fill the forms in the morning and then leave them undisturbed until the next morning.

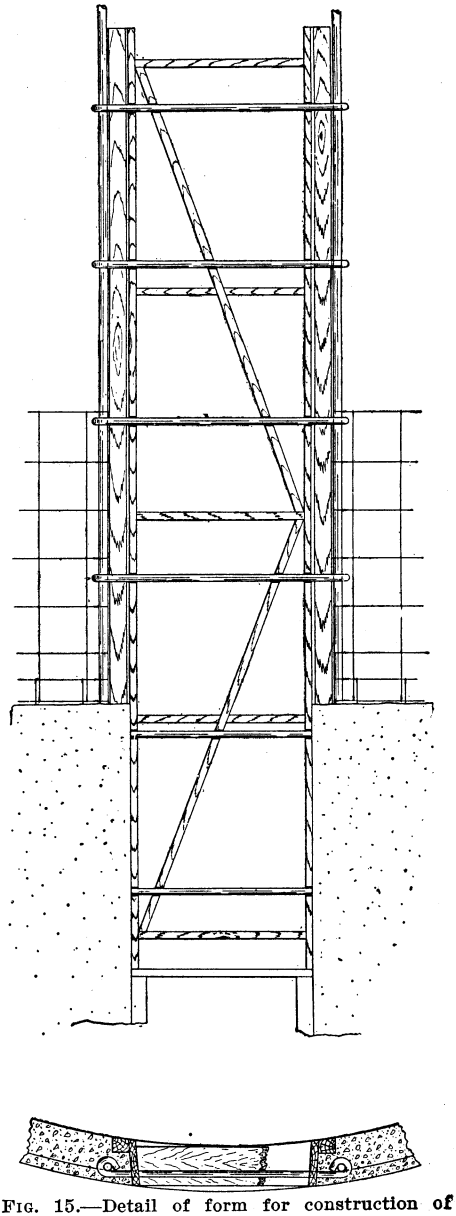

FIG. 15.—Detail of form for construction of continuous door opening.

DOORS.

After the reinforcement around the door opening has been arranged, as shown in figure 11, a form for the making of the door opening should be set in between the wall forms. This form is built of such size and shape (see fig. 13, *a*) that when the concrete is molded about it a 2-inch rabbet is formed around the inside of the opening into which a wooden door can be set, this door being held in place by

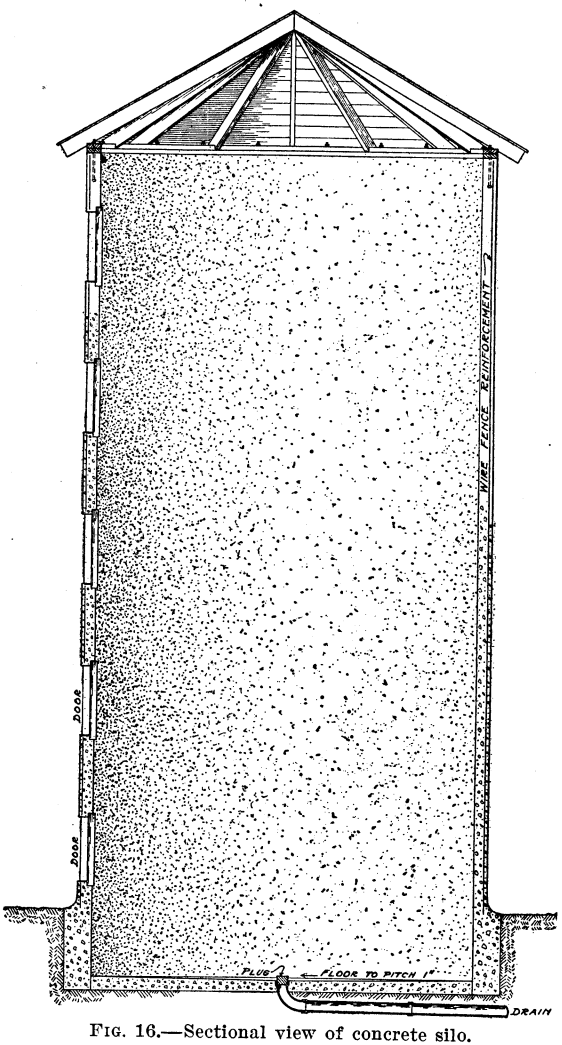

FIG. 16.—Sectional view of concrete silo.

the pressure of the silage on the inside. The piece (fig. 13, *c*) which forms the rabbet at the bottom of the door opening should be left loose so that the concrete can be filled to the bottom of the door opening. In order that the form may be easily removed without injury to the wall, the top and sides are built with a slight taper, which permits the form to slip inward when lightly tapped on the outside. The bottom pieces or sill of the form should be left flat. All the surfaces should be dressed with a plane and greased before using. In placing the concrete about the form, considerable care must be taken to have it well worked in under the sill, or a rough job will be the result. The sills of the doors, especially of the bottom door, receive much wear, and should be protected by a piece of angle or strap iron, which is inserted at the time the rabbet piece is placed.

Unless it happens that the position of the doors exactly coincides with the alternate raising of the wall forms, two forms will be required. The top and bottom pieces of the forms are curved to the circumference of the silo and should be marked off with the slat shown in figure 6 in the same manner as the templet.

Figure 13, *b* shows the design of the silo door. It is made by nailing together two thicknesses of flooring with tar or building paper between. The doors are held in place by the pressure of the silage.

CONTINUOUS DOOR.

On account of the ease with which the silage can be removed through such an opening, many prefer a continuous door opening. A continuous doorway can be made by setting 1-inch pipes vertically, spaced at such a distance as to allow 4 inches of concrete between the pipe and the edge of the door opening. These pipes should extend about 1 foot into the foundation. The reinforcing wire is fastened securely to them, and $\frac{7}{8}$-inch rods extending horizontally across the doorway are hooked around the pipes every 20 inches. These rods serve the purpose of preventing the door jambs from spreading and also carry the strain of the reinforcement across the door opening. (See fig. 14.) When the silo is completed, the rods form the rungs of a ladder for the silo.

The door itself may consist of 2-inch select planking 10 or 12 inches wide, cut in 2-foot lengths, or a door may be made by nailing together two thicknesses of 1-inch boards with building paper between them. (See fig. 13, *b*.) These planks, or these doors, if used, fit into a rabbet on the inside edge of the doorway. This rabbet is formed in the concrete by the use of a form to which are attached 2 by 2 inch strips, as shown in figure 15.

FLOOR.

For the floor, use the same mixture suggested for the foundation wall and lay it about 4 inches deep. Tamp this down well, and over it put a $\frac{1}{2}$-inch surface coat of mortar made by mixing 3 parts sand and 1 part cement. The outlet for the tile drain must be provided for at the time the foundation is put in, but it is suggested that the laying of the concrete floor be left until all the other work of building has been completed.

ROOF AND CHUTE.

For attaching the roof to the silo a number of $\frac{1}{2}$-inch bolts should be set in the top of the wall for bolting down the plate. (See fig. 16.) These bolts are best made from $\frac{1}{2}$-inch rod iron cut into 18-inch lengths, one end to be threaded and the other bent at right angles $2\frac{1}{2}$ inches from the end to prevent the bolt from turning or pulling out.

If the silo is roofed, provision must be made for a door opening for filling the silo. Figure 32 shows a good type of roof with a door in the gable.

To prevent loss in removing the silage, the doors should be inclosed in a chute. For entering the silo, a ladder should be built on the inside of the chute. For attaching the ladder and chute to the silo,

bolt holes may be drilled into the concrete wall, or at the time of building square-taper wooden wedges may set in the wall as the concrete is being filled in. If these wedges are well greased before putting into the wall they are afterward very easily punched out.

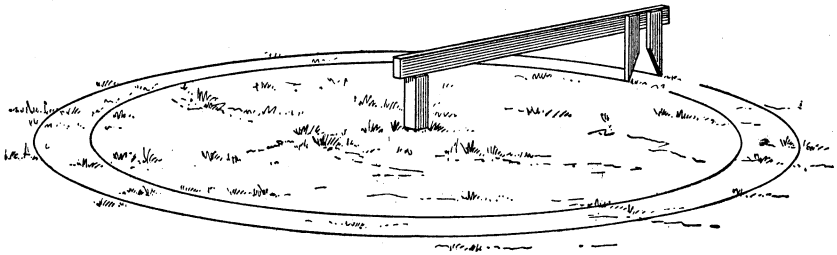

FIG. 17.—Laying off the foundation for a stave silo.

THE STAVE SILO.

FOUNDATION.

The foundation should be constructed of brick, stone, or concrete. Where hard-burned brick are cheap, as is often the case near brickyards, they can frequently be used to advantage for a foundation. They should be laid in cement rather than in lime mortar. If the foundation extends more than 1 foot above the surface of the ground it should be reinforced with heavy wire.

Stone makes a good foundation, but under most conditions concrete is preferable, for it is not only stronger but also generally cheaper than either brick or stone.

LAYING OFF THE FOUNDATION.

Remove any grass or rubbish which may be found at the site of the silo wall and smooth the surface of the ground. Drive a stake firmly in the ground at the center of the proposed silo. Saw the stake off at the height desired for the foundation wall, which should be at least 1 foot above the surface of the ground. One end of a straight 2 by 4 inch scantling, a little longer than is necessary to reach from the

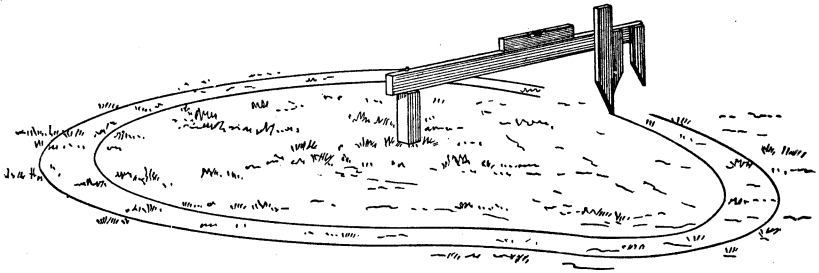

FIG. 18.—Laying off the foundation on sloping ground.

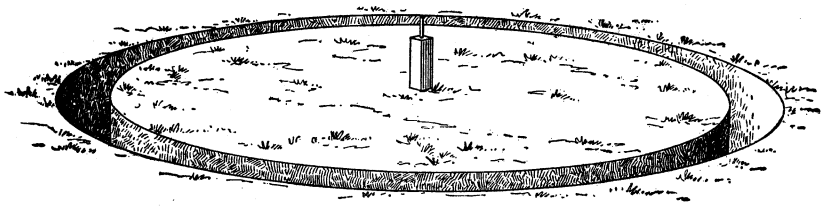

FIG. 19.—Trench for concrete foundation.

center of the silo to the outside of the foundation wall, should be nailed on top of the stake with a 40-penny spike; this spike then marks the exact center of the silo. From it measure on the scantling the distance to the inside and outside of the foundation wall and, having nailed markers on as shown in figure 17, lay off the foundation.

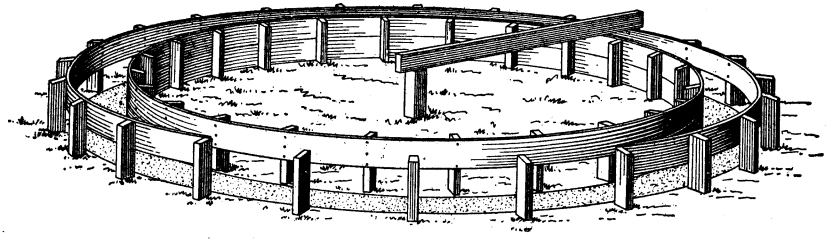

FIG. 20.—Form for foundation above ground partly boarded up.

How much the foundation wall should project on the inside of the silo depends upon how well seasoned the lumber is which is used for staves. If the staves are of well-seasoned wood 3 inches is sufficient; if green lumber is used it is well to allow as much as 6 inches.

Where the ground on which the silo is to be built is not level, the markers can be lengthened by holding a longer board against either marker, as indicated in figure 18, moving it up or down to keep it touching the ground, but care must be taken that the scantling is held level.

Where stone or brick is to be used, the earth in the bottom of the silo, except where the center stake stands, may be dug out before the

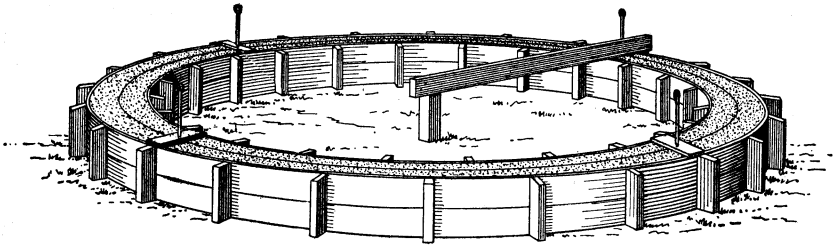

FIG. 21.—Form filled with concrete showing eyebolts and slats in place and circle to mark position of staves.

wall is built, thus allowing greater convenience in building the wall. The earth inside the foundation should not be dug out deeper than within 4 inches of the bottom of the wall. Where concrete is to be used, this excavation should not be made until the wall has been finished and the position of the staves marked on the top of the foundation wall.

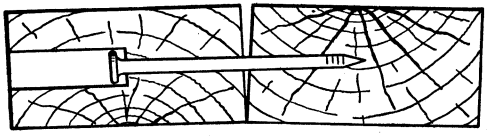

FIG. 22.—Cross section showing how two adjoining staves are spiked together.

CONSTRUCTION OF A CONCRETE FOUNDATION.

For a concrete foundation a circular trench must be dug before any of the earth is removed from the center (see fig. 19). The earth between the two lines that mark the inside and outside of the foundation should be taken out until firm ground below frost line is reached, care being taken to cut the sides of the trench plumb and to leave the bottom level.

Filling the trench with concrete.—Directions for preparing the concrete will be found on page 22. Put the first layer in about 6 inches deep and thoroughly tamp the concrete until water appears on the surface. A good tool for tamping may be made of a piece of 4 by 6 inch lumber, 2 feet long, with a hole bored in one end to receive a round handle 4 feet long. When the second layer is put on, the surface of the first layer should be perfectly clean and rough, and if dry it should be sprinkled with water. Particular care should be taken to keep all dust and loose soil from the surface of each layer, as they prevent perfect adhesion.

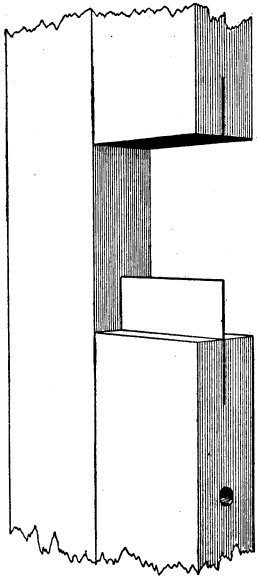

FIG. 23.—Method of splicing ends of staves.

Building forms.—A number of pieces of scrap steel should be embedded in the concrete so as to project 8 or 10 inches above the surface of the ground for the purpose of tying together the concrete above and below the ground level. After the trench is filled to the surface of the ground, drive 2 by 4 inch stakes half an inch from the foundation on the inside and 2 feet apart all the way round. (See fig. 20.) With a straightedge placed level—one end on top of the center stake and the other against the side of the form stake—mark on the form stake the desired height of the wall. Mark thus on every second stake. Take pieces of lumber, perfectly green, one-half inch thick by 6 inches wide, with straight edges, and bend around outside of these stakes, nailing the boards to the stakes, with the top edge

at the marks. Then saw the tops of the stakes off above the boards. (The necessity for this sawing may be avoided by previously driving the stakes down to the exact height.) After the space from the top board to the ground has been boarded in, drive stakes in a similar manner for the outside form half an inch from the concrete. Drive these stakes so that the scantling resting on the center stake and the inside form, as shown in figure 20, will just clear the tops. Board these stakes up on the inside, making the top of the outer form level with that of the inner.

At several places nail slats across the top of the form to keep the inner and outer circles the proper distance apart. After all the boards are on the form is ready to be filled with concrete. (See fig. 21.)

Filling the form.—Eyebolts half an inch in diameter, from 20 to 24 inches long, and with a hook or elbow on the lower end, should be placed 8 inches from the inside of the foundation and held in a vertical position by boards fastened across the top of the form. From 4 to 8 bolts should be used, depending upon the diameter of the silo. The bolts may be put through pieces of board, as shown in figure 21, and the boards afterwards split away with an ax. These bolts should extend 8 or 10 inches above the top of the wall and the concrete filled in around them. They are to be used, after the silo is completed, for securing the wooden part of the structure to the foundation, the staves adjoining the eyebolts being securely fastened to them.

If the wall extends more than 1 foot above the surface of the ground, it should be reinforced by embedding in the concrete, every 8 inches above the surface and near the outer edge, two or three strands of wire with ends tied together. After tamping each 6-inch layer of concrete, work a spade between the concrete and the form to force the coarser materials away from the boards, thus leaving smooth-surfaced walls.

When the concrete is within 1 inch of the top, finish with mortar made by mixing 1 part of cement to 3 parts of sand, and strike off level with the top edges of the form.

After the concrete has set, and before removing the center stake, mark a line with a nail, pencil, or crayon entirely around on top of the foundation wall from 3 to 6 inches from the inner edge (see p. 33) to show where the inside edge of the staves will come. (See fig. 21.)

The dirt inside the foundation may next be dug out to within 4 inches of the bottom of the wall. It should be borne in mind, however, that the bottom of the silo should not be made more than 5 feet below the lowest door and that the bottom of the door will be 1 foot above the foundation.

FLOOR.

The floor should be constructed in the same way as for a concrete silo, directions for which are to be found on page 31.

THE STAVES.

Cypress, long-leaf pine, white pine, cedar, and California redwood are good materials for stave silos. It is important that the staves be straight and free from sapwood, loose knots, and wany edges.

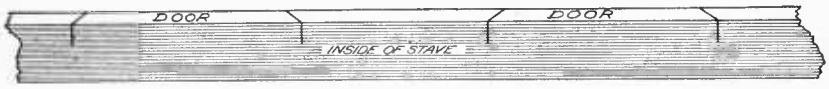

FIG. 24.—Stave partly cut through for doors.

Staves should be made of 2 by 4 or 2 by 6 inch scantling, the latter being preferable, particularly for the larger silos. They should be of the same width and thickness and should be dressed on all sides, the edges being left square. It is considered necessary by some that

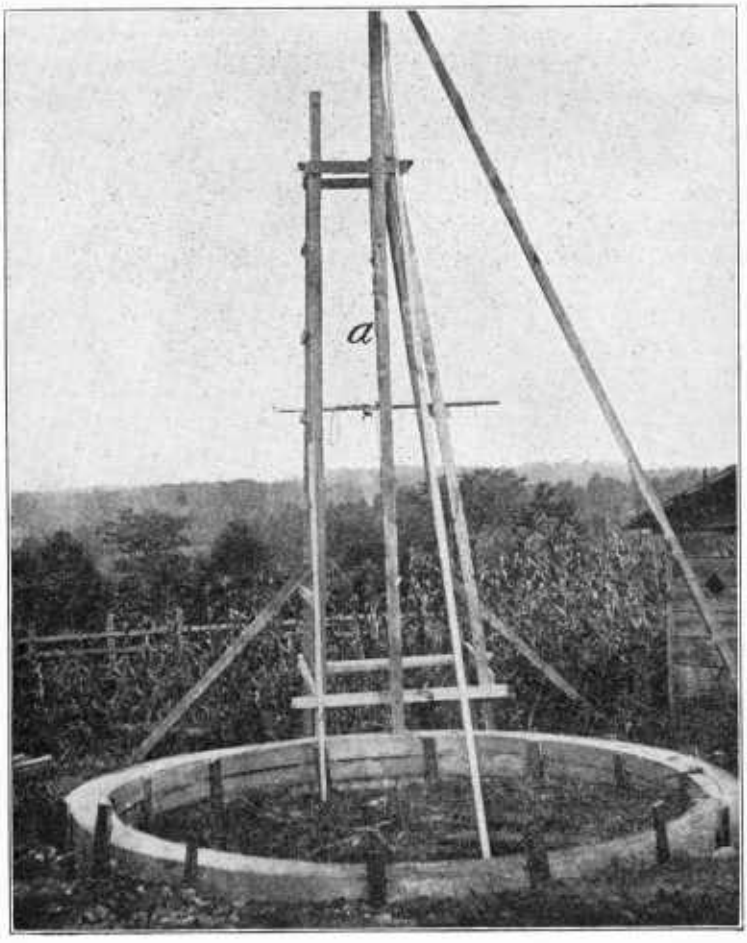

FIG. 25.—The first stave (*a*) in position.

the edges of the staves be tongued and grooved, but satisfactory results can be obtained by using square-edged staves, and at less expense.

After the staves are squared at the ends, half-inch holes from 4 to 6 feet apart should be bored in the edges. These holes are made on one edge only of each stave, and must not be in line in adjoining staves. They should be about 1 inch deep in staves 4 inches wide, and about 3 inches deep in staves 6 inches wide. One of these holes should come within a foot of each end of the stave. Bore the holes perpendicular to the edge of the stave, to avoid having the silo thrown out of plumb. The purpose of these holes is to allow spiking the staves together when set up. The spike is driven to the bottom of the hole and passes through the remainder of that stave and into the adjoining stave, as shown in figure 22. Care should be taken not to put any spikes in those portions of staves which are to be cut out for doors.

It is preferable that each stave be in one piece, but if this is impossible, the staves should be of two pieces of different lengths, splined together by making in the ends to be joined a saw cut 1 inch deep and parallel to the sides of the stave and inserting a sheet-iron spline (preferably galvanized), as shown in figure 23.

CUTTING THE DOOR STAVE.

Before the staves are put up it is necessary to decide how many doors the silo should have, that a door stave may be prepared. The table on page 10 will assist the builder in determining the number of doors and the distance between them. When this has been done, the location of the doors is indicated on a stave and saw cuts are made halfway through for the entrance of the saw in cutting out the doors after the staves are set up. The cuts should be made at a slant of 45° on the edge of the stave horizontal on the front, as shown in figure 24. (See also figure 30.) The object of the slanting cut is to make the doors removable only toward the inside of the silo, and so that when it is full the pressure of the silage will hold the doors in place. The cut for the bottom of each door should slant downward from the outside of the stave, and that for the top should slant upward.

To prevent this stave from being broken in handling, a slat should be nailed on one side of it. This slat should be removed after the stave has been put in position.

When the staves are being put up, the door stave should be placed at one side of the place where the doors are to be cut. After the hoops are put on the silo, a handsaw can be inserted into the saw cuts of the door stave for the purpose of sawing the doors out.

SETTING UP THE STAVES.

In order to nail the staves together at the top when they are being put up, it will be necessary to provide a scaffold. If the silo is not to be more than 25 feet high, a stepladder, as shown in figures 25 and 26, may be used. As the staves are put up the ladder can be moved along and kept in the right place from which to work.

The first stave (fig. 25) should be placed with its inner face on the line (fig. 21) drawn on the foundation wall. It should be plumbed on the face and edge, and securely braced at top and bottom. For this purpose use braces nailed to stakes driven firmly into the ground or to some adjacent building, as shown in figure 25. If this is not done the silo will be out of plumb.

The next stave is then set up and nailed to the first with 30- or 40-penny spikes, which are started in the holes previously bored (fig. 22)

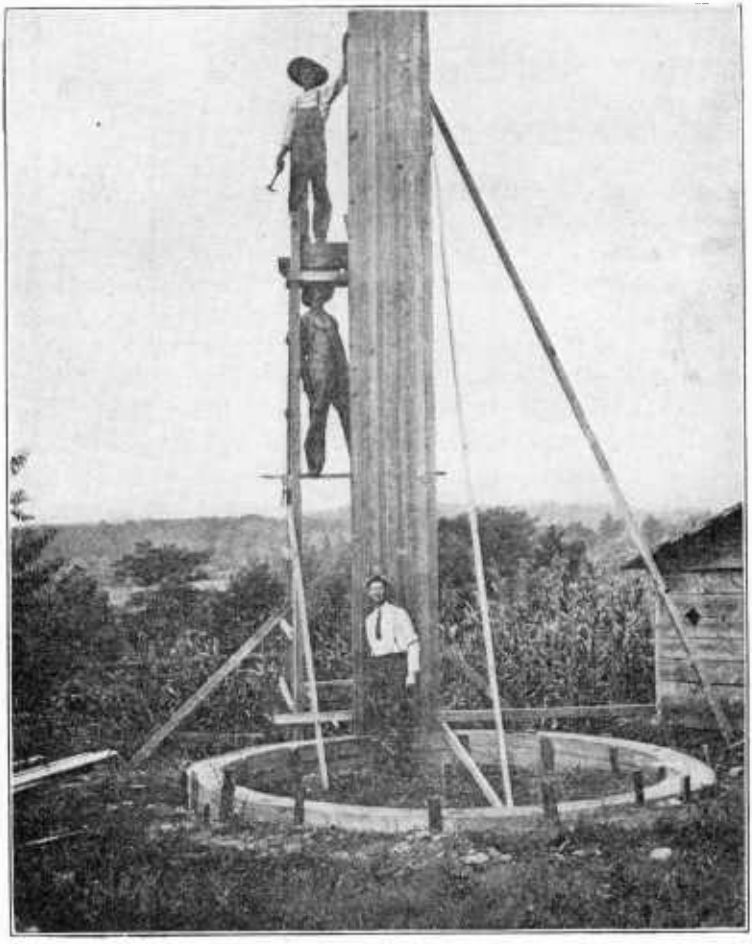

FIG. 26.—Several staves in position.

and driven home with a driftpin. The spikes must not be driven at an angle up or down, for driving at either angle will throw the silo out of plumb.

Other staves should be put up as above described and as shown in figure 26 until the place is reached where the doors should be. The door stave, cut as previously described, should then be nailed in position and the remaining staves set up. In setting spliced staves up the longer and the shorter staves should alternate. (See fig. 27.) Ordinarily it will be necessary to have staves of only two lengths, as, for instance, 16 feet and 12 feet for a 28-foot silo. Figure 27 shows all the staves in position ready for the hoops; the junction points of top and bottom pieces are shown; also the door stave with saw cuts part way through it.

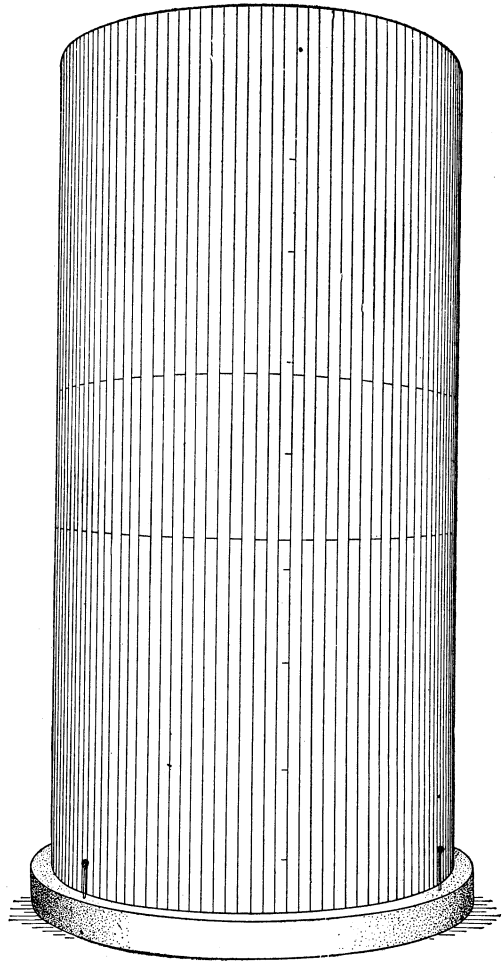

FIG. 27.—All the staves in position ready for the hoops.

THE HOOPS.

The hoops should be made of $\frac{3}{4}$, $\frac{5}{8}$, and $\frac{1}{2}$ inch rods, in sections from 10 to 16 feet in length; the ends of these rods should be threaded 6 inches so that they may be joined together by means of lugs. For silos smaller than 14 by 30 feet the lower hoops should be of $\frac{5}{8}$-inch rods and the upper of $\frac{1}{2}$-inch. For silos larger than 14 by 30 feet the lower hoops should be of $\frac{3}{4}$-inch and the upper hoops of $\frac{5}{8}$-inch, or if three sizes of hoops are used, the lower ones should be of $\frac{3}{4}$-inch, the middle hoops of $\frac{5}{8}$-inch, and the upper of $\frac{1}{2}$-inch rods.

PUTTING THE HOOPS ON.

Two hoops should be placed below the first door, two between doors

all the way up, and two above the top door if this space is more than 2 feet; if less than 2 feet, one is sufficient. Three or four hoops should be put on at the bottom at first and tightened up. Planks can then be thrown across the top of the silo to serve as a scaffold, so that the top hoop may be put on and tightened. The other hoops should then be put loosely around the silo, within reach of the ground, after which they are pushed up to the proper position with slats and from a ladder they are made fast by stapling them to the silo. When all the hoops are in position they should be tightened until the staves are pressed close together. Staples should then be driven over each hoop 2 or 3 feet apart so as to hold the hoops in the proper position in case they get loose.

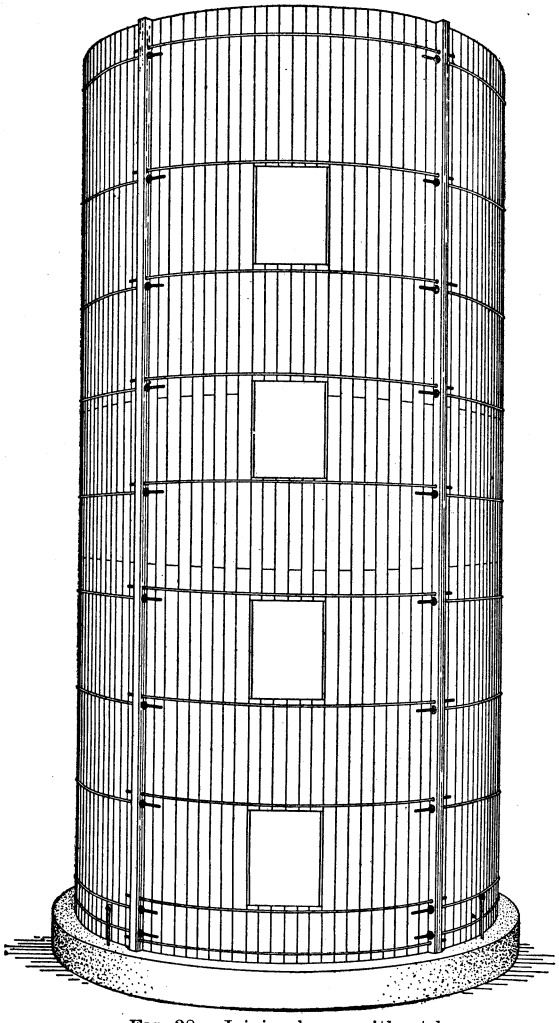

FIG. 28.—Joining hoops without lugs.

JOINING HOOPS WITHOUT LUGS.

It is sometimes very difficult to get lugs for the hoops. In such cases 4 by 6 inch timbers may be put in instead of ordinary staves at the three or four points where the hoops will join. These timbers should be placed with the 4-inch face flush with the staves on the inside and they will extend 4 inches beyond the wall on the outside. Through these outside projections holes should be bored to receive the hoops, and the ends may be fastened with nuts. Large iron washers should be used under the nuts. Such a method of connect-

ing the hoops is shown in figure 28, but its use is advised only when the lugs can not be obtained.

THE DOORS.

After all the hoops are tightened, saw the doors out, beginning with the stave previously cut. Figure 29 shows the lower door completely cut and the second one partly cut. The doors should be about 20 inches wide and 30 inches high. The exact width will, of course, be determined by the width of the staves.

Two cleats, 2 by 4 inches, with one edge cut to the circle of the silo, should be nailed and bolted on the outside of each door (fig. 30) with the nuts on the outside and the bolt-heads sunk flush with the inner surface. The bolts should be $\frac{3}{8}$ inch by 5 inches.

Four bolts in each cleat (two at each end) will be sufficient; the cleats may be nailed to the other strips. After the doors are cut, bolt the silo to the eyebolts shown in figure 21.

A CONTINUOUS DOOR.

To construct a continuous door for a stave silo, a doorframe should be made of 4 by 6 inch timbers, which are kept 20 inches apart by means of pieces of pipe and are fastened together by means of bolts passing through the posts and pipes, as shown in figure 31. Iron washers should be placed between the tim-

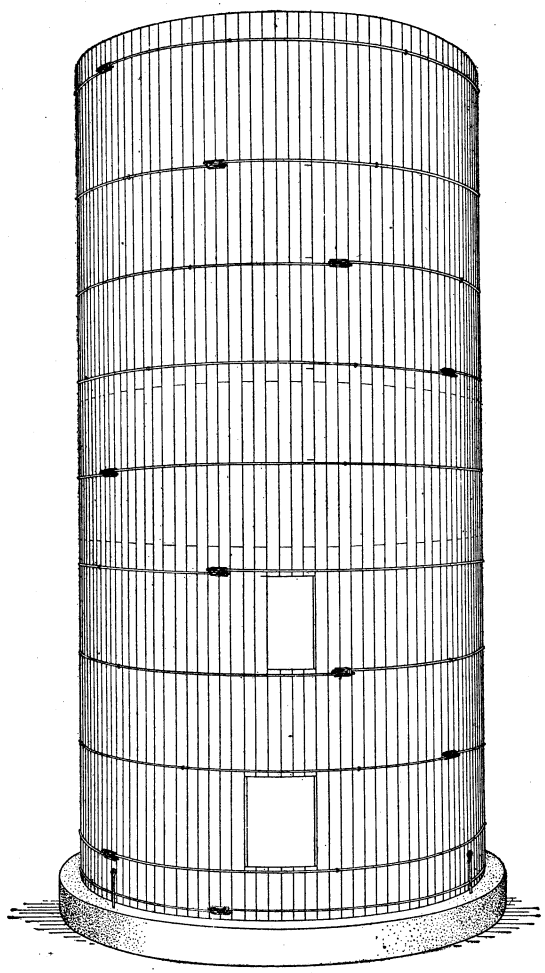

FIG. 29.—Sawing out the doors.

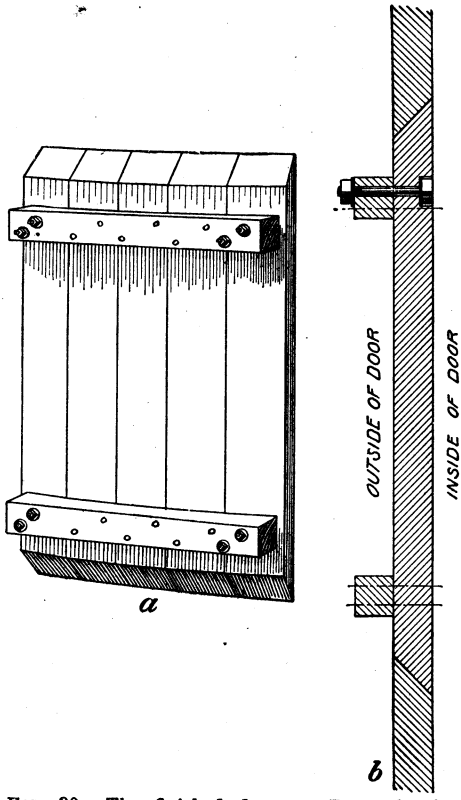

FIG. 30.—The finished door: *a*, Door showing outer face and cleats; *b*, section of side wall showing how door fits.

bers and the ends of the pipe to prevent the pipe from sinking into the timber. Washers should also be used under the boltheads and nuts.

When the doorframe is complete, it should be put in position, plumbed, and securely braced, after which the staves should be put up, as previously described. The doorposts should be flush with the staves on the inside. On the outside they will project beyond the staves, and holes should be bored in these projections to permit the hoops to pass through.

Doors for this frame are made of two thicknesses, of tongue-and-groove flooring with acid-proof building paper between, the inside flooring running vertically and the outside horizontally. The doors are held in position by means of iron straps, one on each side, which project over a slat nailed to the doorpost. When the silage is being used, instead of the doors being removed from the frames, they are slid up out of the way and held by a pin in the doorpost. The topmost door will have to be taken out, and this will make room for the other doors to be raised, one at a time, enough to give an opening.

As shown in figure 31, the doors are so made as to overlap where they meet and thus make a tight joint.

ROOF, LADDER, AND CHUTE.

Figure 32 shows the framing and boarding for a good type of roof, with the door in a gable for filling the silo.

Figure 33 shows the same roof as figure 32, but with a trapdoor for filling, in place of the door in the gable.

A ladder should be attached to the silo at one side of the doors, and a chute, through which to remove the silage, should be so built as

to inclose the ladder and the doors, as shown in figure 34. This should be large enough to permit a man to climb the ladder conveniently. In case the continuous door is adopted, the ladder may be dispensed with, as the hoops will serve as rungs of a ladder. (See fig. 31.)

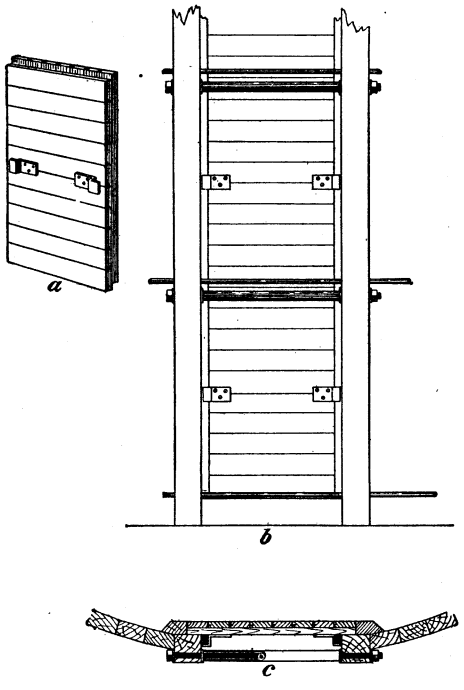

FIG. 31.—A continuous door: *a*, A section of the door; *b*, doorframe with door in position; *c*, cross section showing door and frame.

PAINTING.

Before the silo is filled, it should be painted on the inside with raw coal tar thinned with gasoline. Every two or three years a fresh coat of this paint should be put on. When the timber in the silo is thoroughly dry, the outside of it should be painted to harmonize with the surrounding buildings.

THE MODIFIED WISCONSIN SILO.

FOUNDATION.

The foundation for the modified Wisconsin silo is constructed the same as for a stave silo. Instead of eyebolts, anchor bolts 16 inches long should be used. These should be embedded in the foundation wall 6 feet apart and 3 inches from the inside edge, extending 5 inches above the top of the wall. (See fig. 37.)

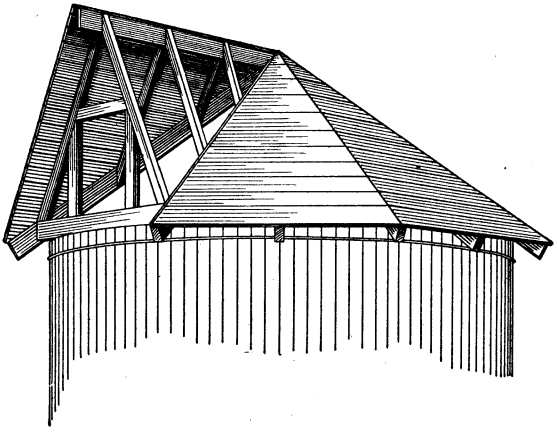

FIG. 32.—Roof with door in gable.

SILLS AND PLATES.

The sills and plates are formed of two thicknesses of 2 by 4 inch pieces, 2 feet long, with the ends beveled to form a

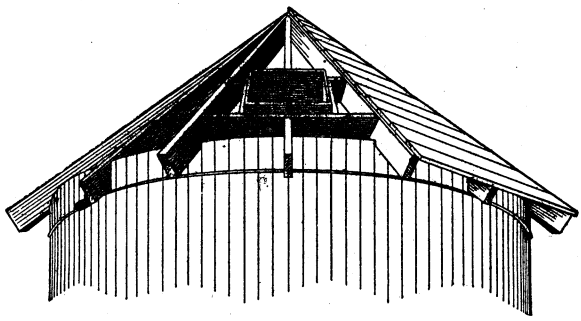

FIG. 33.—Roof with trapdoor for filling silo.

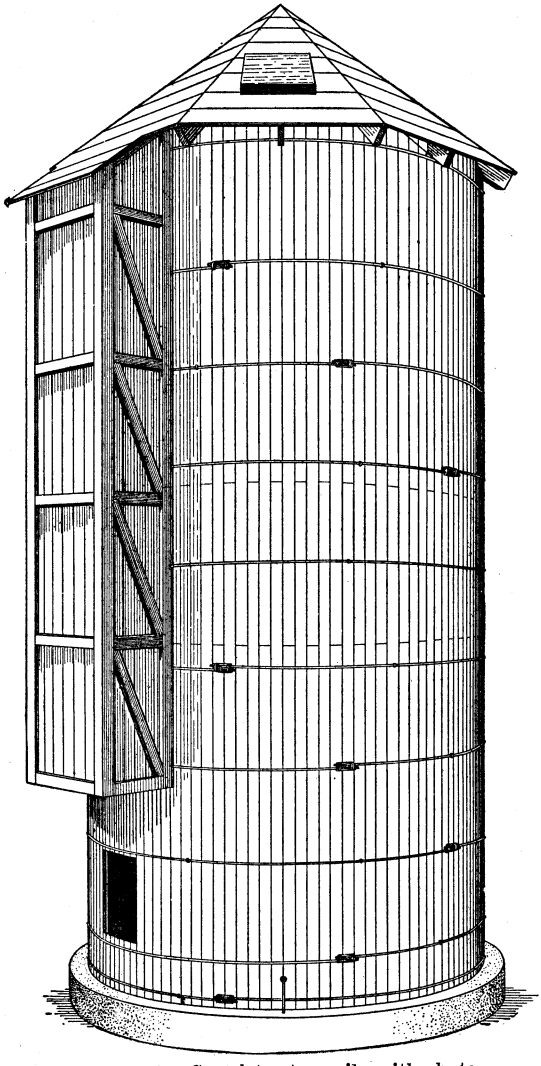

FIG. 34.—Complete stave silo with chute.

circle. The proper bevel may be determined in the following manner: From the center stake used in laying out the foundation wall draw a circle on top of the foundation wall 1 inch from the inside edge. At any point on this line lay a 2 by 4 inch piece, 2 feet long, with both ends at equal distances from the center; then use a slat with one edge on the center point of the stake and let the same edge on the other end of the slat strike the outer corner of the 2 by 4 piece. A line drawn along the slat across the 2 by 4 piece will give the proper angle, or the bevel. The same process will give the bevel for the other end of the 2 by 4 piece. (See fig. 35.)

Use this piece as a pattern in cutting pieces enough to form the double circle for both sill and plate. The number needed will depend on the diameter of the intended silo. After cutting several pieces, lay them along the wall and note how they fit, and make any necessary changes. When all the pieces are

cut lay them out on the wall along the line 1 inch from the inside edge of the wall, boring the necessary holes for the anchor bolts. On this layer place the second course, breaking the joints, then nail the two rings together and tighten the nuts on the anchor bolts.

SCAFFOLDING.

As it will be necessary to have a scaffold inside the silo to put the sheathing on, it is preferable to put it up before the studs are in posi-

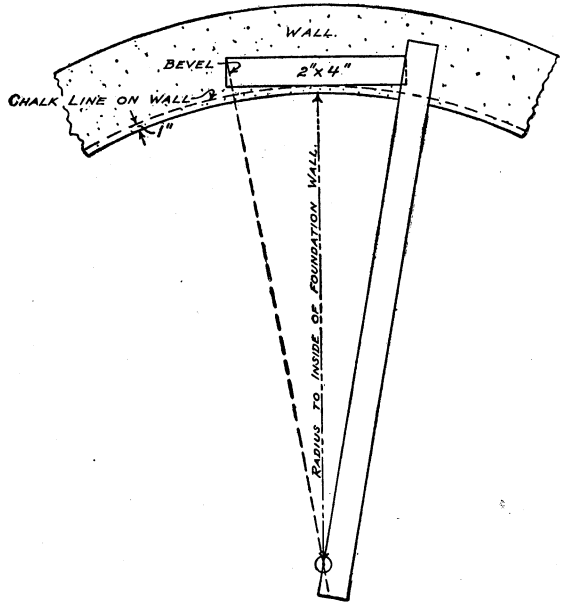

FIG. 35.—Method of obtaining bevel ends for sill and plate.

tion. It can easily be made by standing up a pole in the center of the silo, with about six others around it, placed about 18 inches inside the foundation wall. Then brace the poles together, and wherever a stage is desired, nail pieces from the center pole to each of the outer poles, on which boards may be laid.

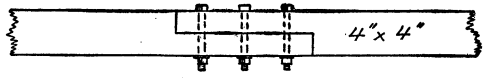

FIG. 36.—Method for splicing doorposts.

DOORPOSTS.

It is preferable to set the doorposts before the studs are placed, so as to avoid trouble in getting the door in just the right place. The doorposts should be 4 by 4 inches and long enough for the height of

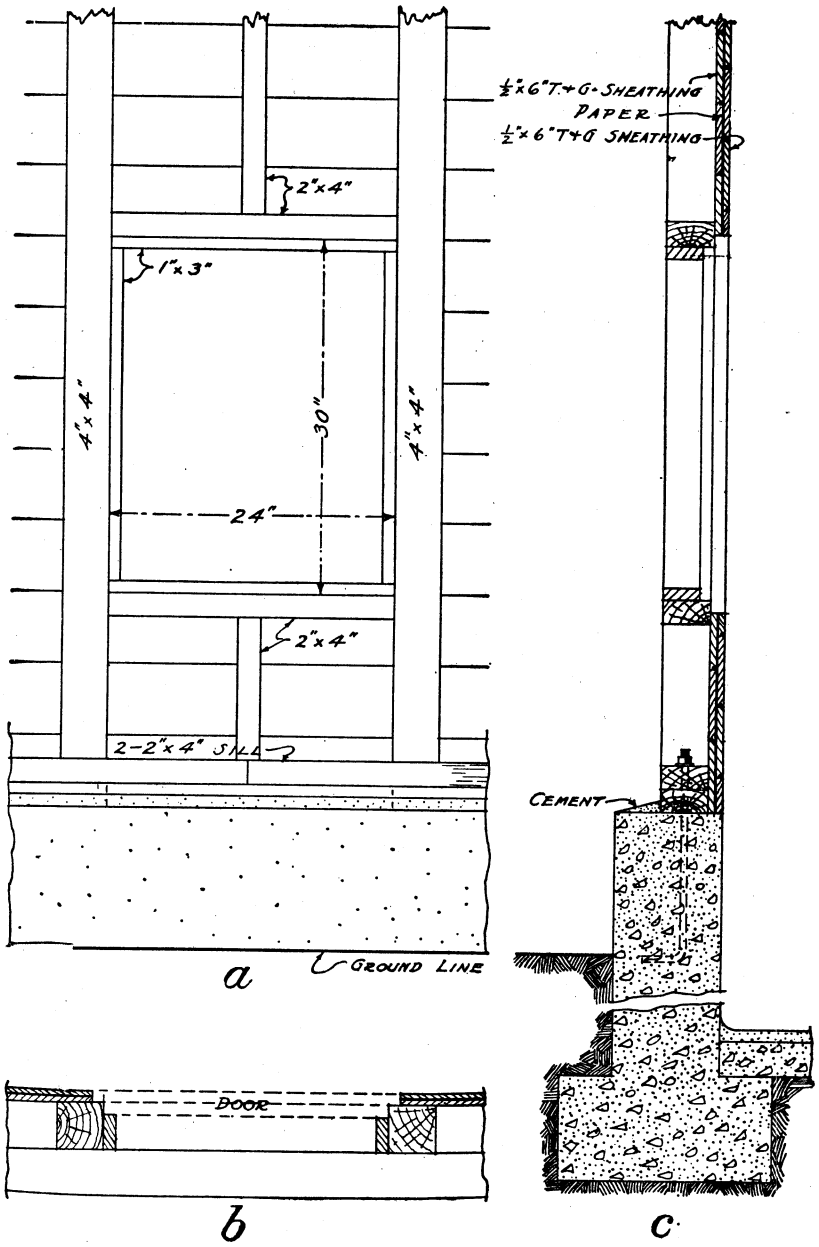

FIG. 37.—Details of construction of modified Wisconsin silo; *a* and *b*, detail of door opening; *c*, section view of foundation and wall.

the silo. If not, they may be spliced by halving and bolting. (See fig. 36.) Set them up to the line 1 inch from the inside edge of the foundation wall, leaving a 24-inch space between. Toenail securely to the sill. The openings for the doors are made by nailing in

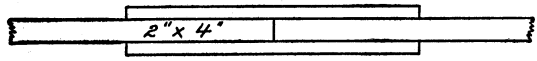

FIG. 38.—Method for splicing studding.

headers and sills at the places where the doors are desired, leaving the spaces open when the inside sheathing is put on. For the size of the openings see figure 37, *a*.

STUDDING.

The size of the studding used in the modified Wisconsin silo is 2 by 4 inches, and if not long enough to reach the desired height they can be spliced with 1 by 4 inch pieces, 4 feet long, nailed on each side over the joint. (See fig. 38.) Whenever it is necessary to splice the studs the pieces should be of two different lengths, such as 12 feet and 16 feet for a 28-foot silo, and in setting the studding up the long and short pieces should alternate, so that all the splices will not come at the same height from the foundation.

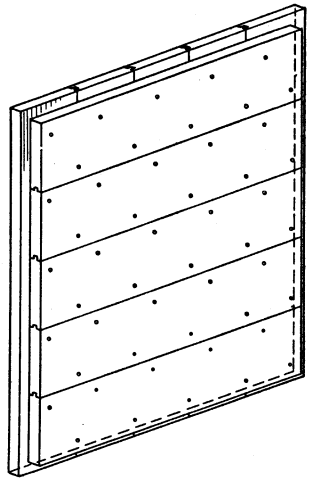

FIG. 39.—Door for modified Wisconsin silo (outside view).

It is preferable to do this splicing before the studs are placed in position. When all are spliced and cut to equal length they should be placed 1 foot apart from center to center, with the edge 1 inch from the inner edge of the foundation wall, or in line with the circle previously marked out in laying the sill, and then toenailed to the sill. Great care should be taken to have the studs plumb on all sides and well braced to the inside scaffold so that the top of the silo will form a perfect circle. The pieces which form the plate can be nailed

on as the studs are set and should be laid in the same way as the sill, being careful to nail them firmly to the top of the studs.

At least two hoops formed from the thin sheathing should be nailed around the outside of the studding to keep them from bulging while the sheathing is being nailed on. These hoops can be removed after the sheathing has been placed on the inside.

SHEATHING.

The sheathing should consist of ½ by 6 inch material. Start at the bottom and work upward. To prevent uneven bending, the joints of the sheathing should come on different studs. At the door openings the sheathing should be cut back 1 inch from inside edge of doorposts to form a rabbet into which the doors should fit. (See fig. 37, *b*.)

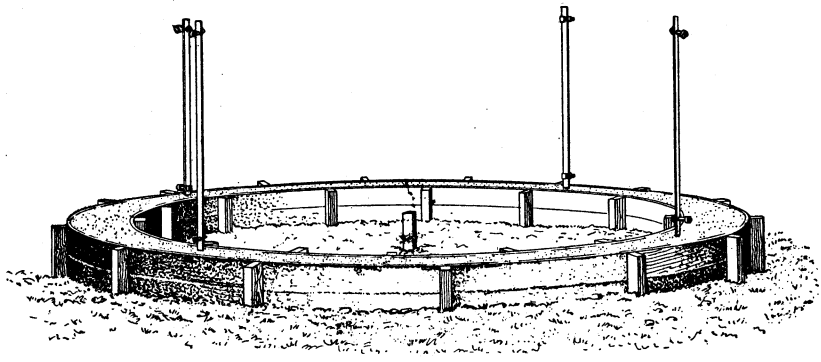

FIG. 40.—Foundation for wooden-hoop silo, showing anchor irons.

Two courses of the sheathing are put on the inside with a course of acid-proof building paper between. (See fig. 37, *c*, which is a sectional view of the foundation and wall through the door opening.) In placing the sheathing see that all seams and joints are broken—that is, so that the cracks and joints in the first course will not come opposite to those of the second. It is more convenient if these two courses are carried up to the top simultaneously.

DOORS.

The doors are made of two thicknesses of 1 by 6 inch tongue-and-groove flooring, with acid-proof building paper between, and should fit neatly into the door opening. The inside layer should be vertical and the outside layer horizontal. (See fig. 39.) A 1 by 3 inch strip is then nailed around the door openings 1 inch from the inside of the studs to form the outside door jambs.

ROOF, FLOOR, LADDER, AND CHUTE.

The roof, the floor, the ladder, and the chute are constructed just the same as for a stave silo.

THE WOODEN-HOOP SILO.

FOUNDATION.

The foundation for a wooden-hoop silo should be constructed as for a stave silo (see p. 32), except that the inside diameter should be only 4 inches smaller than the inside diameter of the silo wall, thus allowing for a 2-inch shoulder between the inside of the foundation and the wall. This allows for possible imperfections in workmanship. Four to six anchors, made from $\frac{3}{8}$ by $1\frac{1}{2}$ inch strap iron, 46 inches long, with the lower ends bent up 2 inches, should be imbedded in the foundation wall. Two holes for half-inch bolts should be drilled in these irons, one 2 inches and the other 24 inches from the upper end. The anchor irons (see fig. 40) should be placed in the foundation wall $2\frac{3}{4}$ inches farther from the center of the silo than the inside of the silo wall, with the lower hole 4 inches above the top of the foundation, so that they can be bolted through the two lower hoops to the silo wall.

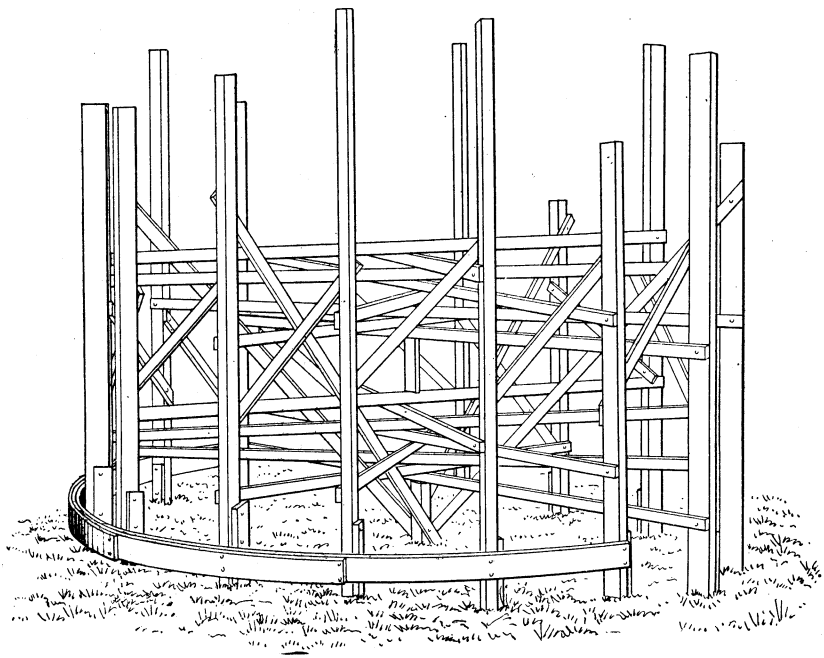

FIG. 41.—Form for building hoops for wooden-hoop silo.

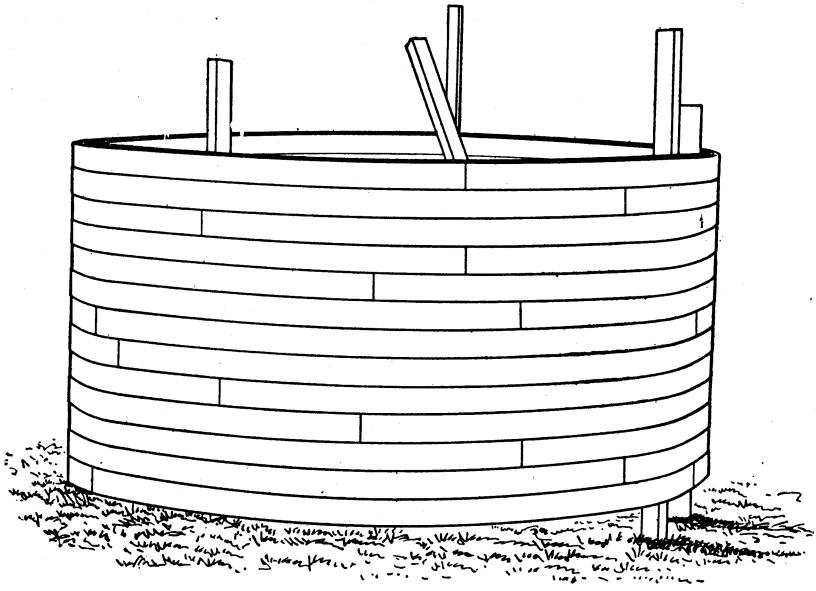

FIG. 42.—Hoops for wooden-hoop silo completed.

BUILDING THE FORM FOR THE HOOPS.

A form should be constructed on which to build the hoops. First drive a 2 by 4 inch stake and saw it off 1 foot from the surface of the ground. With a 10-penny nail fasten one end of a strip a few inches longer than the radius of the proposed silo to the top of this stake. Measure from the nail 1 inch longer than the radius of the silo, and cut the strip off at this point. One inch toward the center, from the outer end of the strip, drive a 1 by 4 inch stake about 20 inches long, swing the strip halfway around the circle and drive similarly another 1 by 4 inch stake in line with the first and the center stake; swing the strip quarter way around and drive a third stake, and place a fourth stake in the same manner as the second stake. Proceed in this way (see fig. 41) and drive additional stakes around the circumference so that the space between the stakes will be approximately 2 feet. Fasten to these stakes 2 by 4 inch uprights about 6 feet long, with their outer edges plumb and flush with the end of the

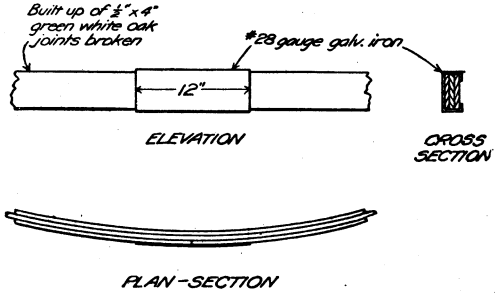

FIG. 43.—Showing covering of outside joints of wooden hoops.

measuring strip. When all the uprights are in place remove the measuring strip. Tie opposite 2 by 4 inch uprights at the bottom with 1 by 1 inch strips or edging material cut to the exact diameter of the form, which is the same as the outside diameter of the silo wall. These strips should be marked in the middle, the lowest one nailed at this point to the top of the center stake and the remainder nailed to each other at these marks. Beginning about 4 feet from the ground, tie the upper part of the uprights in similar manner. The uprights should be plumbed and braced to each other, and about four braces should be run from the uprights to the center stake.

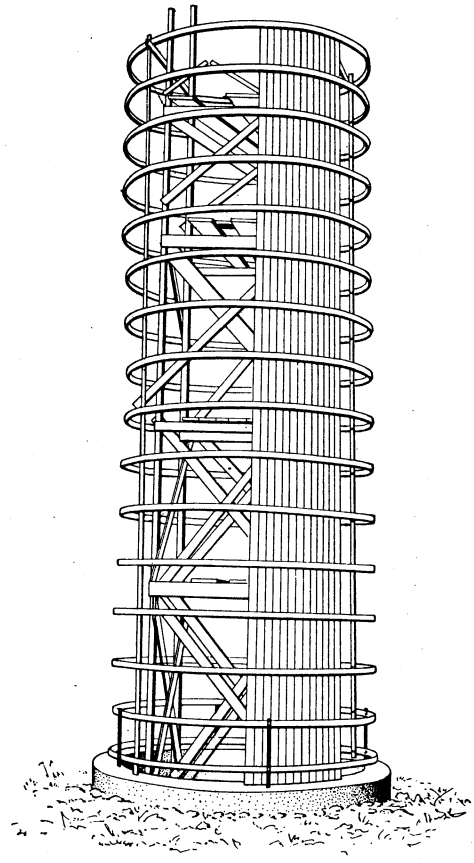

FIG. 44.—Showing scaffold and hoops for wooden-hoop silo, with some of the staves nailed in place.

MAKING THE HOOPS.

The hoops are made of ⅜ to ½ by 4 inch oak, elm, ash, pine, or chestnut. They are usually made three ply, except for the larger heights and diameters, when four-ply hoops are used. Make a mark on the outside face of one of the uprights about 6 inches above the ground. Level around from this mark with a carpenter's level, marking each upright. The marks indicate the position of the upper edge of the first hoop. Now fasten one end of the hoop material (see fig. 41) to one of the uprights, so that it will bend around the form to the left; nail it to each upright with the upper edge flush with the marks. At the third upright begin the second ply of the hoop, at the sixth the third ply, and bend the boards around the form, nailing to each upright with 8-penny nails, and between the uprights and at the joints with 6-penny nails. Break joints. Butt joints in the outer layer should be carefully fitted. Start the second hoop on the next stud to the left of the place where the first hoop was started, and

continue as before. The number of hoops required is one-half the height of the silo, in feet, plus 1. Thus a 30-foot silo requires 16 hoops.

When all the hoops are completed (see fig. 42) they are numbered from the bottom up, and perpendicular lines are drawn in four places to assist in plumbing the hoops when raised in position. The form is now torn out and all nails in the hoops clinched. All joints in the outside layer of each hoop should be covered with pieces of galvanized iron 12 inches long (see fig. 43) to protect the joints from the weather. The hoops are next placed on the foundation in the same order and position as on the form, with one of the perpendicular lines immediately on the left of the proposed door opening.

ERECTING THE SCAFFOLD.

The scaffold is made of four or five uprights built up of 2 by 4 inch pieces doubled for ordinary heights of silos. They are placed 18 inches from the silo wall to provide for working space. The uprights should be set on blocks or flat stones and should be well braced. The floors of the scaffold should be spaced 7½ feet apart, beginning at the top of the foundation.

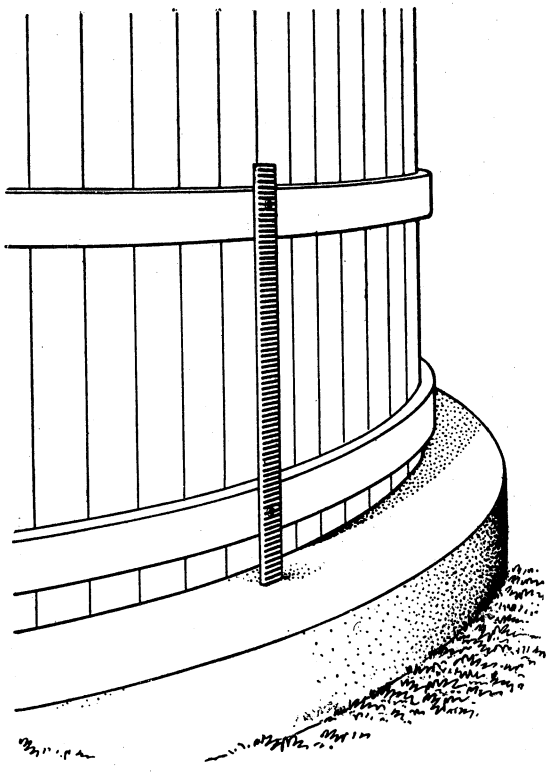

FIG. 45.—Showing method of bolting wooden-hoop silo to foundation.

SPACING THE HOOPS.

On the ground splice four staves, each equal to the height of the silo, and mark on them the spacing of the hoops. The mark for the first hoop should be 6 inches from the bottom of the stave, the next three marks are spaced 23 inches, and the remainder 24 inches, except the last two, which are spaced 23 inches. These staves are

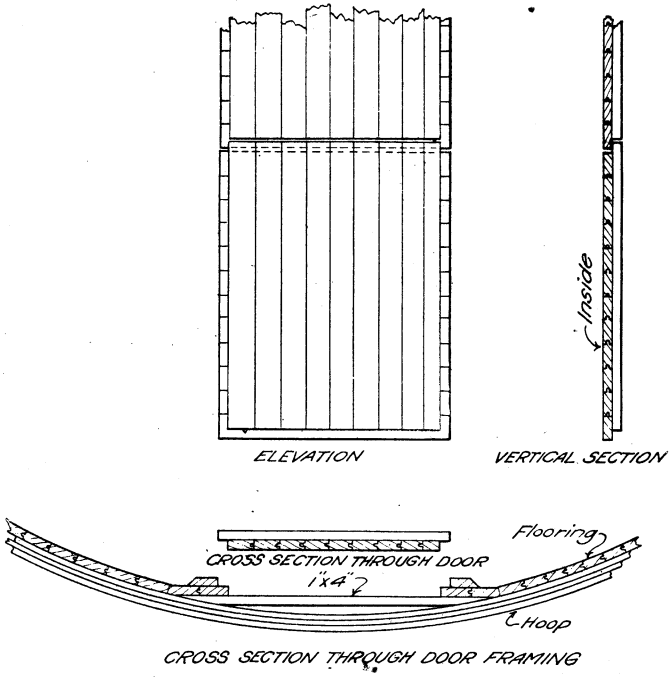

FIG. 46.—Showing detail of door opening and door for wooden-hoop silo.

now placed in position on the foundation, and the bottom of each stave is nailed temporarily to the bottom hoop flush with the perpendicular lines drawn on the hoops. The top hoop is now raised by means of ropes and nailed in position to the top of the spacing staves and supported from the scaffold by 2 by 4 inch pieces. The remaining hoops are raised and fastened to the spacing staves in their proper positions. The hoops are then plumbed at the spacing stave placed on the left of the proposed door opening and braced to the scaffold. The remaining spacing staves are then plumbed and the hoops braced to the scaffold.

NAILING THE STAVES ON.

The first stave is carefully plumbed and nailed on at the left of the door opening. Nail the staves on as flooring is laid, driving the tongue into the groove and "blind nailing" to each hoop with two nails. (See fig. 44.) Break joints in adjoining staves, and have all joints made on hoops. Plumb edge of staves about every 5 feet around the wall, and continue nailing the staves on until the opposite side of the door opening is reached. The opening left should be about 35 inches to allow for fitting in the door jambs and a door 24 inches wide. Bolt the silo to the foundation (see fig. 45), running $\frac{1}{2}$ by $3\frac{1}{4}$ inch bolts through staves, hoops, and anchor irons.

DOOR JAMBS AND DOORS.

Cut pieces of 1 by 4 inch lumber 35 inches long, bevel the ends to fit the inside curve of the hoops, and nail the ends of one of these pieces across the opening on the inside of the upper hoop and one on the inside of the lower hoop. The remaining pieces are similarly fitted and placed in position on the hoops, carefully plumbed and nailed into place. (See fig. 46.) These pieces form stops for the tops and bottoms of the doors. After these crosspieces are in place, nail an additional stave on each side of the opening. Next prepare

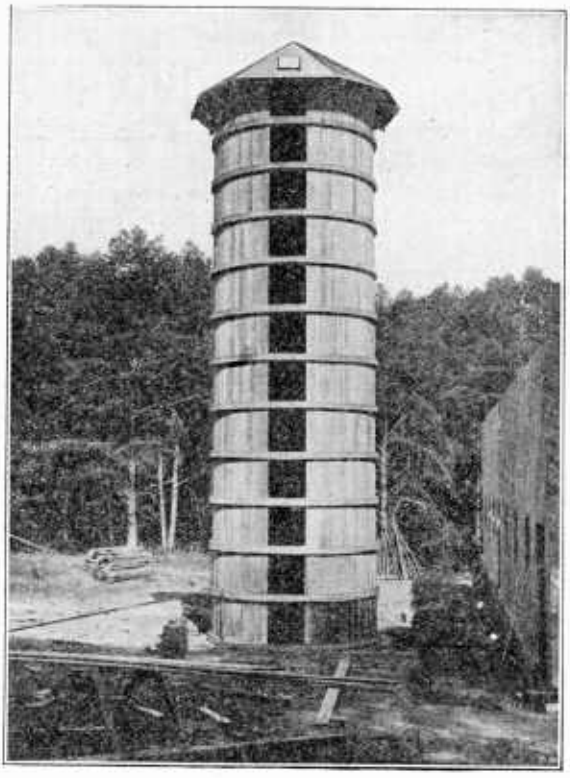

FIG. 47.—Wooden-hoop silo.

two other staves for door jambs by removing the tongue from one of them and the groove from the other and fasten them into place on each side of the opening. Care should be taken to see that the finished door opening is of uniform width from top to bottom. On the inside of the door jambs and 1 inch back from the edges of the door opening, fasten 1 by 3 inch strips, the back edges of which are beveled back toward the inside of the wall.

The doors are made of two thicknesses of tongue-and-groove flooring, with acid-proof building paper between. On the inside the

flooring is placed horizontally and on the outside vertically. The inside layer projects 1 inch beyond the outside layer on sides and bottom. The outside layer projects 1 inch beyond the inside layer on the top.

ROOF, FLOOR, AND CHUTE.

The roof, the floor, and the chute are constructed as for a stave silo.

BILLS OF MATERIALS.

One of the main questions which will confront the farmer who undertakes to build his own silo is, "What materials shall I need and how much of each kind?" Owing to the variation in size of silos it is impracticable to give such information in detail here. If any farmer who desires such information will address a request to the United States Department of Agriculture, Washington, D. C., or to its local representative, stating the size and kind of silo he intends to build, a complete list of the materials needed will be forwarded to him free of cost.

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August 15, 1930

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